Malic Acid 6/29/73

D19

MALIC ACID 1969-1973
TO BE ADDED TO REVIEW PB-223 865
A Jean Ala. Stone (Portland)

570
dehydrogenase, endogenous levels of pyridylate nucleotides and adenylate kinase in sour and sweet lemon fruits.
Abou-Zamzam, A. M.
Dissertation Abstracts International. Section B. The Sciences and Engineering 30 (5) 2046 (1969) [En] [Univ., Los Angeles, California, USA]

10 A 257
[The nomenclature of lactic, malic and tartaric acids.] Zur Nomenklatur von Milch-, Äpfel-, und Weinsäure.
Adriaanse, A.; Pilnik, W.
Deutsche Lebensmittel-Rundschau 65 (7) 208-09 (1969) [10 ref. De] [Lab. für Lebensmittelchemie und Lebensmittelmikrobiologie, Landwirtschaftliche Hochschule, Wageningen, The Netherlands]

9 H 1358
[Correction of the acidity of musts and wines.] [A lecture]
Andreev, V. V.
Bulletin de l'Office International du Vin 44 (488) 910-912 (1971) [Fr]
The U.S.S.R. report in the series states that the most important acids in wines are tartaric and malic acid; less important are citric, glycolic, succinic and oxalic acid. The normal acidity of musts and wines is respectively is 7-9 g/l. and 6 ± 2 g/l. (as tartaric acid), the pH 2-3 and 3.0-3.5 and the tartaric/malic acid ratio 0.7-1.5 and 0.3-2.0. Acidity is corrected by mixing varieties or the addition of citric or tartaric acid (≤2 g/l. is allowed). To wines of the "Xeres" type a max. 2 g/l. $CaSO_4$ is added before pressing the vintage. Cation exchange resins may also be used, thus eliminating mainly K ions; this method shows good economic and technological prospects. Deacidification, apart from natural biological deacidification, is effected by addition of $CaCO_3$ (≤3 g/l.), which may cause tartrate problems or undesirable biological deacidification. Ion exchange methods show good prospects. JMS

6 H 831
[Methods of analysis and constituents of wines. Report of the 12th assembly of the sub-committee on the unification of methods of analysis and appreciation of wines, Paris, 20-21 April 1970.]
Anon.
Bulletin de l'Office International du Vin 43 (473/74) 767-98 (1970) [Fr]
A report of discussions at the assembly on the following is given: I. Methods of regulating constituents of wines and musts (citric acid, malic acid, CO_2, succinic acid, phosphates, total N, nitrates, Mn, ascorbic acid, sulphates, Pb, sorbitol, chlorides, methanol, Mg, leucoanthocyanins, glycerol and butylene glycol; II. Tracing of preservatives in wines (ethyl pyrocarbonate, sorbic acid) including use of chromatography; III. Tracing of possible additives in wines (caramel, furfural and hydroxyfurfural), synthetic colourings, synthetic sweeteners and meta-tartaric acid; IV. The oenological Codex (second part); V. Enzymes (oxidases), vitamins and N-containing substances; VI. Analysis of sparkling wines; VII. Adoption of limits for certain constituents of wine (diglucosides, SO_2, superfluous Na); VIII. Check-in and testing of methods, physics

Good technique
These references predominantly relate to [illegible] naturally occurring Malic acid (and) in fruit [illegible] foods [illegible] not Malic acid as a food additive + toxicity testing of the compound
(Sent this list only to FASEB + FDA May 15 1974)

Quality dried fruit without sulphur; ascorbic acid/malic acid dip maintains colour, flavour.
Anon.
Food Processing 33 (5) 25 (1972) [En]
Dehydrated peaches, pears and apricots have been prepared at the University of California by dipping in 1.0% ascorbic acid and 0.25% malic acid for 3 min prior to dehydration. Although colour was not equal to that of sulphured fruit, flavour was judged to be superior. PG

[Correction of the acidity of musts and wines.] [A lecture]
Anon.
Bulletin de l'Office International du Vin 44 (488) 906-910 (1971) [Fr]
The South-African report in the series states that in South African grapes and wines the most important acids are malic and tartaric acid; the citrate content of white grapes varies from 60 to 250 mg/l. The total acidity varies with the variety from 5 to 12 g/l.; the variety White French (Palomino) shows an extremely low acidity of ≤4 g/l. The ratio tartaric acid/malic acid generally ranges between 1.1 and 2.4; the pH varies normally between 3.0 and 3.5, in hot regions up to 3.9. Acidification of wines is necessary only in cold regions where only small amounts of table wines are produced and is effected by: tartaric acid addition (legally permitted), mixing of the vintage with mature grapes and exchange treatments with anion resins. The latter is not recommended because of the unfavourable effect on bouquet and taste of the wine. JMS

[Novel trends in the preparation and handling of red wines.]
Asvany, A.
Borgazdasag 18 (2) 55-64 (1970) [25 ref. Hu] [Orszagos Szöleszeti es Boraszati Kutato Intezet, Budapest, Hungary]
Following detailed discussion of procedures for red wine preparation (fermentation, heating, and fermentation in a CO_2 atm.), and of the particular methods applied in France in the various wine-producing regions, expt. with must from the Kekfrankos variety of Egar-region blue grapes are described. After adjusting the pH value with $CaCO_3$ from 3.01 to 8.2 and 7.2, a treatment with 100 mg/l. SO_2 and fermentation for 8 days followed. After storage for ~3-4 months, the lime-treated wine batches had a much smoother taste and more desirable flavour, and contained 3.38-3.48 g/l. malic acid (7.50 g/l. in untreated control batches). An improved preparation technique for producing Hungarian red wines in 14 steps is briefly presented. IF

B

Induced malo-lactic fermentations of New York State wines.
Barretto de Menezes, T. J.; Splittstoesser, D. F.
New York's Food and Life Sciences 5 (1) 24-26 (1972) [3 ref. En] [Dept. of Food Sci. & Tech., St. Agric. Expt. Sta., Geneva, New York, USA]
Results of an investigation into growth conditions, fermentation rates and enzymic conversion of malic acid by Leuconostoc citrovorum MI. 34 are discussed. Max. growth rate in terms of the shortest generation time was found to be 17 h at 30°C. Higher temp. (30-36°C) gave max. malic enzyme activity. Optimum pH for growth was 4.5-5.4, but decarboxylation rate was most rapid at pH 3.4-4.4. Experiments involving inoculation of wines followed by incubation showed that malolactic fermentation was extremely difficult to induce when ethanol levels exceeded 6.0% and pH levels were <4.0. Introduction of bacterial and yeast cultures simultaneously into grape musts to allow bacteria to adapt gradually to increasing concn. of alcohol was successful in causing complete malolactic fermentation only in the case of red wine. The studies underlined the extreme

Influence of different organic acids on the firmness of fresh-pack pickles.
Bell, T. A.; Turney, L. J.; Etchells, J. L.
Journal of Food Science 37 (3) 446-449 (1972) [23 ref. En] [USDA, N. Carolina St. Univ., Raleigh, 27607, USA]

Acetic, lactic, citric, malic and oxalic acids were studied as to their ability to cause texture changes in fresh-pack (pasteurized) cucumber pickles. All of these except malic were evaluated for their equilibration rates with whole cucumbers and found to follow an exponential curve. Oxalic acid equilibrated at the fastest rate, followed by acetic, lactic and citric acids. Acetic acid treatments showed the least effect on cucumber firmness, followed by lactic, citric, malic and oxalic acids. From a texture standpoint, it would be better not to have the acids fully equilibrated with the cucumbers at the time of pasteurization. During storage, most of the acidification treatments, although apparently free of microbial growth, increased in titratable acidity and decreased in pH values. This unexplained change in acidic conditions was accompanied by a loss in pickle firmness. Acetic acid proved superior to the other acids tested in retaining cucumber firmness. The use of lactic, citric, malic or oxalic acids in the manufacture of fresh-pack pickles would not be recommended. Acetic acid (vinegar) should remain the acidulant of choice to give the best texture to pickle products. IFT

10 J 1594
[The acidification of peeled tomatoes.]
Bellucci, G.; Porretta, A.; Leoni, C.; Aldini, R.
Industria Conserve 47 (1) 32-34 (1972) [19 ref. It, fr, en, de] [Sta. Sperimentale per Ind. delle Conserve Alimentari, Parma, Italy]

In an investigation of the effects of acids on peeled tomatoes, 0.1-0.3% malic, citric and tartaric acids were added in 1969 to samples of tomatoes and 0.1-0.3% citric and tartaric acids were added to samples in 1970. Prior to acid addition the tomatoes were steam-treated for 10 min and sterilized in an autoclave at 103°C for 37 min. Dropping wt., wholeness, total acidity, pH, container vacuum, colour and organoleptic qualities of the treated tomatoes were investigated. Results showed that the % of whole tomatoes increased with increasing acid concn. i.e. 90.7% for 0.1% and 94.7% for 0.2% citric acid treated samples. Total acidity also increased. Organoleptic qualities were not affected when ≤0.2% tartaric acid and ≤0.3% citric acid were added. pH of the tomatoes was lowered by this treatment to such an extent that the conventional heat treatments could be carried out on the samples. LA

12 H 1822
[Natural and controlled microbiological processes in grape must and young wine.]
Natürliche und gesteuerte mikrobielle Vorgänge im Traubenmost und Jungwein.
Benda, I.
Bayerisches Landwirtschaftliches Jahrbuch 47 (5) Sonderh. 19-29 (1970) [44 ref. De] [Bayrische Landesanstalt für Wein-, Obst-, und Gartenbau, Würzburg, W. Germany]

Yeast strains added to grape must after pasteurization produced wines of varying quality. Use of single-strain yeasts produced wines which in some respects received a lower rating than wines inoculated with mixed strains. Schizosaccharomyces spp. which broke down malic acid in ethanol and led to a reduced acid content in the wine gave satisfactory results. IN

Beridze, G. I.; Sikharulidze, T. G.
Vinodelie i Vinogradarstvo SSSR No. 3, 54-55 (1972) [1 ref. Ru] [Nauchno-issled. Inst. Sadovodstva, Vinogradarstva i Vinodeliya MSKH Gruzinskoi SSR, USSR]

Paper chromatography was used to determine the content of some organic acids (tartaric, oxalic, citric, malic, glycolic, pyruvic, lactic, succinic, fumaric) in selected red and white wines of different types and different years. The white wines contained a higher proportion of organic acids. During ageing of wine, considerable changes took place; malic and citric acids decomposed, forming pyruvic and fumaric acids. During prolonged storage pyruvic acid disappeared as well. The organic acids have a considerable effect on the quality and organoleptic character of aged wine. STI

Respiratory activity of different fruits on storage at different temperatures and relative humidity.
Bhattacharyya, G. C.; Ghosh, J. J.; Bhattacharyya, K. C.
Indian Journal of Applied Chemistry 32 (1) 36-42 (1969) [11 ref. En] [Dept. Applied Chem., Univ., Calcutta-9, India]

(i) Oranges (Coorg variety), (ii) bananas (Singapuri) and (iii) mangoes (Langra) were stored for 7, 14, and 21 days at 4° and 32° C ((i) and (iii)) or 20° and 30° C (ii) at 75 and 85% RH. Oxidation of glucose, fructose, mannose, and galactose, also of sodium salts of pyruvic, succinic and malic acids were studied after homogenation of the pulp. O_2 uptake was measured manometrically. Oxidation of sugars in (i), (ii) and (iii) increased at the higher temp. of storage from 14 to 22 μl O_2/h/mg N of extract in the presence of glucose for (i) after 21 days storage, 10-16 μl for (iii) and 10-18 μl for (ii). A higher storage humidity decreased respiratory activity for (i) (glucose from 20-16 μl O_2) and (ii), but no appreciable difference was noted for (iii). Oxidation of organic acids increased in all cases on storage at the higher temp. (pyruvate from 8-14 μl O_2 for (ii)), but was not affected by changes in RH. PEG

Influence of the origin and of thinning on the quality of Golden Delicious apples.
Iobade, B.; Lezec, M. le; Babin, J.
Bulletin Technique d'Information 1972 (266) 11-27 (1972) [Fr] [INRA, Sta. de Recherches Fruitieres d'Angers, 49-Beaucouze, France]

Fruit was harvested from 6 orchards at weekly intervals from about the middle of Sept. and stored at 1°C in an RH of 90%. The results of tasting tests on Dec. 9th 1969, Jan 26th and March 9th 1970 were analysed according to Friedman's formula, described in the annex to the paper. Significant differences between orchards were observed. With increasing maturity of the fruit at harvesting, the refractive index (RI) and hydrolysable sugar (HS) content of the juice increased regularly while the total acidity (TA) decreased. The Thiault index, ST + 10A (where ST is g of total sugar/l. of juice and A is equivalent g of malic acid/l. of juice), remained constant during harvesting. Mean values for all the fruit harvested at each orchard showed significant differences between orchards, particularly in the HS content of the fruit (coeff. of variation 13.1%). Similar chemical analyses at the time of tasting showed that HS and TA values decreased while the RI increased slightly and then remained constant during storage. From analyses of the results using the Friedman formula, the Thiault index was shown to be the best for differentiating between orchards. Relationships between taste of fruit and chemical analyses of the juice are discussed and values of 13 for RI and 30 g/l. for HS at harvest are recommended for assuring a good taste. The effect of thinning the fruit on the size and quality of the crop was also studied. It was concluded that 30 leaves/fruit was the optimum. MEG

12 J 1943
[Gora Chirine, an Iranian grape variety with a low organic acid content.]
Boubals, D.; Bourzeix, M.; Guitraud, J.
Annales de l'Amelioration des Plantes 21 (3) 281-285 (1971) [2 ref. Fr, en] [Sta. de Recherches Viticoles, Centre de Recherches, INRA, 34-Montpellier, France]

The chemical composition of Gora Chirine table grapes was compared with that of Sultanine grapes from the same botanical family. 1 wk before harvesting, the m-equiv. of tartaric, citric and malic acid/kg of Sultanine grapes was 107, 5 and 161 respectively, compared with 10, 0 and 4 respectively in Gora Chirine grapes which also contained 2 m-equiv. of lactic acid/kg. At maturity, the tartaric acid content was reduced to 69 m-equiv./kg of Sultanine grapes and no citric or malic acid was detected. The mature Gora Chirine grapes contained similar levels of tartaric and malic acids to the immature grapes, but no lactic acid was present. The low acid content of the Gora Chirine grape makes it of interest for metabolic studies, and it is also suggested that it might be used to breed wine grapes with low juice acidity. MEG

2 H 271
[Identification of organic acids and determination of their individual contents in musts and wines by chromatography and photodensitometry.]
Bourzeix, M.; Guitraud, J.; Champagnol, F.
Vignes et Vins 192, 16-17 (1970) [Fr] [Sta. Centrale de Tech. des Produits Vegetaux, 11-Narbonne, France]

A method is described for separating the organic acids of white wine, grape juice and must or red wine (charcoal- or Dowex 50-treated to remove anthocyanins) by ascending chromatography on cellulose, using the upper phase of a mixture of butanol:formic acid:water (4:2:5) as developing solvent. The dried chromatogram is prayed with a mixture of 20 ml of a 10% arabinose solution, 22 ml of 10% analine in ethanol and 58 ml of n-butanol, followed by heating at 90°C for 6 min in the dark. The next day the acids show as brown spots with R_f values of 0.13 (tartaric), 0.23 (citric), 0.34 (malic), 0.55 (citramalic), 0.69 (lactic) and 0.79 (succinic). Sorbic, benzoic and salicylic acids do not interfere. Gluconic (R_f 0.44), α-ketoglutaric (R_f 0.55) and glucuronic acids may also be detected if they are present at high concn. The amount of acid present in each spot was measured by scanning with a Vernon type TRD 5 photometer, 15 h after heat treatment of the chromatogram. Relative errors ($P = 0.05$) for tartaric, lactic and succinic acids in wine were respectively ±5.3%, ±4.0% and ±4.2%. MEG

11 H 1256
[Study of malic acid metabolism in vinification. Beaujolais wines, observations during the 1962-1968 campaigns.]
Brechot, P.; Chauvet, J.; Croson, M.; Irrmann, R.
Annales de Technologie Agricole 18 (4) 293-305 (1969) [17 ref. Fr, en, es, it] [Lab. des Fermentations, Inst. Pasteur, 75-Paris (15e), France]

The authors show that during vinification by the Beaujolais method, malic acid is metabolized by bacteria, grapes and yeasts. They discuss the importance of malate fermentation and its relationship to alcoholic fermentation in the vinification process. DJS

1 J 17
The nature and inheritance of sweetness and acidity in the cultivated apple.
Brown, A. G.; Harvey, D. M.
Euphytica 20 (1) 68-80 (1971) [15 ref. En] [John Innes Inst., Norwich, Norfolk, UK]

A survey was made of the sweetness and sourness of the fruits of apple cultivars. Measurements of the concentration of sugars and malic acid in ripe fruits were made and the variation between samples of a cultivar, between cultivars, between years and between cultivars and their tetraploid and colour sports was studied and showed a wide range of variation between cultivars but fairly constant values within cultivars. The study of a number of progenies shows that sweetness and sourness are inherited independently. Sweetness shows a quantitative pattern of inheritance and the progeny mean approximates the mid-parent value. Sourness is controlled by a single gene, with medium and high acidity being dominant to very low, superimposed on a quantitative pattern. The mean sugar and acid concentrations of a progeny and the approximate range of variation can be predicted from the sugar and acid concentrations found in the parents. AS

3 J 371
Biochemical changes in grapefruit during anaerobic metabolism.
Bruemmer, J. H.; Roe, B.
Proceedings of the Florida State Horticultural Society 83: 290-294 (1970) [11 ref. En] [US Fruit & Vegetable Products Lab., Winter Haven, Florida, USA]

Immature Duncan grapefruit picked in June and July were treated with air, N_2 or CO_2 at 100 F for 16 and 32 h. The longer treatment was interrupted after 16 h by an 8 h holding in air at 70 F. Citrate, malate, isocitrate, glutamate and pyruvate ions, and acetaldehyde and ethanol were determined enzymatically on juice serum. Activities of malic enzyme, malic dehydrogenase, pyruvic decarboxylase and alcohol dehydrogenase were measured. Total acidity, citrate and malate ions were decreased by gassing for 16 h (to 1.64%, 97 mM and 1.2 mM from 1.80%, 102 mM and 3.9 mM for N_2) compared to control fruit held in air at 70 F. Gassing with N_2 or CO_2 increased ethanol content from 0.4 mM to 12.8 and 23.0 mM respectively, and aldehyde content from 0.12 mM to 0.37 and 0.37 mM respectively. Decreases in citrate and malate ions paralleled lower acidities in anaerobic and heated grapefruit during the rapid growth and acid accumulation stage. After 32 h treatment, citrate ion values for anaerobic samples were substantially lower than values for air samples at 70 and 100 F. Data for enzyme activities showed that treatment at 100 F had a varying effect on enzyme activities. CO_2-treated samples had highest concn. of pyruvate ions, acetaldehyde and ethanol, and lowest malic enzyme and pyruvic decarboxylase activities. PG

[Investigations on the metabolism of sugar beet during the growing period. II. Citric, malic and α-ketoglutaric acids.] Stoffwechselphysiologische Untersuchungen an Zuckerrüben während der Vegetationszeit. II. Citronensäure, Äpfelsäure und α-Ketoglutarsäure.
Burba, M.; Nitzschke, U.
Zucker 25 (16) 509-518 (1972) [21 ref. De, en, fr] [Inst. für Pflanzenzüchtung, Kleinwanzlebener Saatzucht AG, 3352 Einbeck, Federal Republic of Germany]

Analyses of citric, malic and α-ketoglutaric acids showed that their contents in beet were similar during the same period of vegetation. Whereas the content was fairly high at the beginning of the analysis period (mid-July and earlier), there was a decline, relative to refractometer solids of press juices, with progress of the vegetation period. From mid-Sept. onwards values with only a slight downward trend were reached. Citric acid values were 490-680 mg/100 g solids depending on variety, malic acid contents were about 90 mg/100 g solids. Large variations of citric acid depending on environmental factors became apparent in variety trials at several locations in Germany and abroad, where contents between 269 and 1058 mg/100 g solids were observed at the end of the vegetation period. Even in a population which was uniformly cultivated, variations for this trait were greater than ±40% of the trial mean ($\bar{x}$ = 95.7 mg/100 g solids). Only small quantities of α-ketoglutaric acid were found in sugar beet (9.5 mg/100 g solids), without a sharp seasonal decline. Varieties with high sugar content always contained less citric and malic acid (200 and 35 mg/100 g solids respectively) than high yielding ones. With an increase in mineral fertilizers (N, K, Na) and a decrease in population density citric acid content rose. Close correlations existed between citric and malic acid and sucrose and K content respectively, e.g. for citric acid correlation coeff. were -0.60 to -0.69 for % sugar; +0.77 to +0.88 for K. [See FSTA (1972) 4 1L66 for part I.] AS

[Changes in acid composition of grape and of must during processing.]
Burdzhanadze, V. F.; Medzmariashvilli, F. V.; macharashvili, T. G.
Trudy, Gruzinskii Nauchno-Issledovatel'skii Institut Pishchevoi Promyshlennosti 5: 65-68 (1971) [4 ref. Ru] [Gruzinskii Nauchno-issled. Inst. Pishchevoi Promyshlennosti, USSR]

Values are tabulated for contents of tartaric and malic acids in (i) Rkatsiteli, (ii) Chinuri, (iii) Tsolikauri and (iv) Tsitska grapes during ripening. Apart from these 2 main acids, chromatographic analysis showed the presence of oxalic acid in (i)-(iv), of succinic acid in (i), (iii) and (iv), and of citric and fumaric acids in (iii). Further tabulations show characteristics, including acid contents, of 3 batches each of (i) and (iv) fresh must, wine after racking and wine after storage for 4 months. Final values for total and bound tartaric acid were: (i) 2.0-2.6 and 1.4-1.6; and (iv) 2.3-3.0 and 1.0-1.3. No malic acid was detected. Total titratable acidities were 4.5-7.2 and 5.5-10.2 respectively; values for lactic acid (detected chromatographically) are not given. SKK

[Degradation of malic acid in grapes by intracellular fermentation in an anaerobic liquid medium.]
Buret, M.; Flanzy, C.; Chambrow, Y.
Comptes Rendus Hebdomadaires des Seances de l'Academie d'Agriculture de France 57 (8) 622-631 (1971) [6 ref. Fr] [INRA Sta. de Tech. des Produits Vegetaux, Montfavet, Vaucluse, France]

The effect of solutes in the surrounding medium on the intracellular enzymic degradation of malate in whole grapes was studied. Ethanol, always present in fermentation vats, and tartaric acid and SO_2, which are sometimes added to the vats, were all shown to have an inhibitory effect on the [illegible]

[Evolution of malic acid during anaerobic intracellular fermentation of grapes in the dark. Influence of vine type and temperature.]
Buret, M.; Flanzy, C.
Comptes Rendus Hebdomadaires des Seances de l'Academie d'Agriculture de France 56 (7) 418-22 (1970) [7 ref. Fr] [Sta. de Tech. des Produits Vegetaux, INRA-CRA du Sud-Est., Montfavet, France]

Anaerobic intracellular fermentation of grapes is characterized by synthesis of ethanol and reduction in malic acid content. From a study of the kinetics of degradation of malate of grapes, these phenomenon are shown to be functions of vine type and temp. An equilibrium between the disappearance of the malate and evolution of CO_2 can occur during the first few days. HSi

[Relationship between temperature and sugar accumulation and changes in contents of tartaric and malic acids in ripening grapes.]
Butanescu, G. D.
Industria Alimentara 20 (5) 254-57 (1969) [11 ref. Ro, en, fr, de, ru] [Sta. Expt. Viticola, Dragasani, Roumania]

Data are presented and discussed on sugar accumulation and changes in tartaric and malic acid contents in relation to temp. in ripening, ripe and harvest-ripe Sauvignon grapes on 5 viticultural stations in the Dragasani vineyard area in 1960-1966. SKK

[Quantitative determination of organic acids (tartaric, citric, malic, maleic, fumaric) by paper chromatography.]
Bzhasso, N. A.; Pyatnitskii, M. P.
Izvestiya Vysshikh Uchebnykh Zavedenii, Pishchevaya Tekhnologiya No. 4, 155-156 (1971) [2 ref. Ru] [Kubanskii Gosudarstvennyi Univ., USSR]

C

[Non-volatile organic acids of Phaseolus vulgaris L.: development in the fruit.]
Cailliau-Commanay, L.; Cavalie, G.
Comptes Rendus Hebdomadaires des Seances de l'Academie des Sciences, Serie D Science Naturelles 271 (2j) 2313-15 (1970) [8 ref. Fr] [Centre de Physiol. Vegetale, Fac. des Sci., 118, route de Narbonne, 31-Toulouse, Haute-Garonne, France]

Contents of citric, fumaric, glycolic, malic, malonic and succinic acids were measured in whole pods, beans and empty pods of the haricot bean (variety Contender) at different stages of development. Malic acid accounted for 66-72% of the total organic acids present in the whole pod. The malonic acid content (9-16%) was lower than in the leaves. Citric acid increased from 5.8 to 9.0% with increasing development of the pod. In the seeds, the malic acid content decreased from 47 to 26% with increasing maturity, while the citric acid content increased from 34 to 67%. Malonic acid was present only in trace amounts. The other acids decreased to low levels in the mature beans. The empty pods contained a constant amount of organic acids, with malic acid predominating. The origin of the citric acid accumulated in the bean seeds is discussed. MEG

Sugar and organic acid concentrations in cultivars of muscadine grapes.
Carroll, D. E.; Hoover, M. W.; Nesbitt, W. B.
Journal. American Society for Horticultural Science 96 (6) 737-740 (1971) [11 ref. En] [N. Carolina St. Univ., Raleigh, USA]

Individual and total sugar and organic acid concn. in the juice of 12 cultivars of muscadine grapes (Vitis rotundifolia Michx.) were determined in each of 3 yr. Fructose ranged from 3.35 to 9.28% and averaged 5.51%; glucose 3.52-7.70%, average 5.16%; sucrose 0-5.20%, average 1.89%; soluble solids 10.20-17.85%, average 13.21%; malate 0.17-1.16%, average 0.50%; tartrate 0.15-0.52, average 0.26%; citrate ranged from a trace to 0.06%, average 0.04%; total titratable acidity 0.39-1.549%, average 0.839%; pH ranged from 3.50 to 2.88. 'Roanoke' was significantly lower in soluble solids (11.18%) than most of the other cultivars over the 3-yr period. It was also exceptionally high in malic acid (0.70%) and contained significantly more malate than 7 other cultivars. 'Roanoke' and 'Pamlico' averaged the highest titratable acidities with 1.099 and 1.049%, respectively. 'Magoon' contained significantly more tartrate (0.41%) than all other cultivars except 'Hunt'. When total titratable acidity values for the 12 cultivars were pooled for each season, it was apparent that yearly differences in these values were primarily due to differences in malate levels since tartrate levels were similar in each of the 3 seasons. AS

[Degradation of L-malic acid by Schizosaccharomyces pombe Lindner.]
Castelli, T.; Hasnedari, S.
Vini d'Italia 10 (55) 265-72 (1968) [32 ref. It] [Inst. di Microbiologia Agraria E Tecnica, Univ. Perugia, Italy]

10 cultures of Schizosaccharomyces pombe and 1 of S. malidevorans caused marked reduction in malic acid content of a synthetic medium. Activity of S. pombe was inhibited by Saccharomyces ellipsoideus. Using grape juice puree, enriched with malic or tartaric acid, synthetic medium containing malic or tartaric acid, grapes of different maturity (i. e. acidity), fermentation by S. pombe followed after 3-4 days by S. ellipsoideus produced almost total disappearance of malic acid. RM

[Succinic acid in wines. II. Factors affecting its formation.]
Castino, M.
Vini d'Italia 12 (67) 289-97 (1970) [20 ref. It] [Instituto Sperimentale per l'Enologia di Asti, Italy]

The rapid spectrophotometric method described in Part I [FSTA (1970) 2 5H547] was applied to the study of grapes, musts and wine. Analytical results obtained for 27 different types of Italian wine are tabulated. Factors determining the succinic acid content of the finished wine are shown to include: malic acid content and assimilable N in the must, fermentation temp. and level of anaerobiosis. No correlations were found between contents of succinic acid and alcohol, glycerol, 2,3-butanediol or 2-methyl-malic acid. The ability of various skin-forming Saccharomycetes e.g. Pichia membranaefaciens, to metabolize some of the succinic acid present in wine was confirmed. Finally an organoleptic evaluation of the relationship between succinic acid content and the bouquet of a wine is reported. ECA

[Possibility of recovering malic acid from fermentation industry waste.]
Cenci, P.; Cremonini, B.
Industrie Alimentari 8 (12) 72-74 (1969) [2 ref. It, en] [Lab. Analchimica, Centro Ricerche, Ferrara, Italy]

Of the 3 methods tested (immersion in boiling water, UV irradiation, steaming) for complete inhibition of malolactic fermentation, only steaming proved unsatisfactory. The following operations are suggested for recovering malic acid from waste from the alcoholic fermentation of apples: surface sterilization of the apples with UV lamps (30 W) placed ~30 cm from apples being conveyed to the cutting machine; precipitation of the Ca salt of the malic acid from the centrifuged waste; and purification of the free malic acid after its recovery by acidification. Average yield is ~8 kg malic acid/ton original apples. CEB

Nonvolatile acids of passion fruit juice.
Chan, H. T., Jr.; Chang, T. S. K.; Chenchin, E.
Journal of Agricultural and Food Chemistry 20 (1) 110-112 (1972) [16 ref. En] [Fruit Lab., USDA, Honolulu, Hawaii, USA]

The nonvolatile acids were extracted from yellow and purple passion fruit, separated by TLC and identified as lactic, malonic, malic, citric, ascorbic, and galacturonic. GLC of the methyl esters of the acids confirmed the presence of lactic, malonic, malic, and citric acids and revealed the presence of succinic acid. Quantitative analysis by GLC using adipic acid as an internal standard showed yellow and purple passion fruit differed in both total acid content and in the relative proportions of each of the acids. AS

Malic acid.
Chazan, M. S.
Food Industries of South Africa 24 (6) 23 & 25 (1971) [En]

Chemical and physical properties of malic and citric acid, their physiological taste effect and content in natural fruits are compared. Malic acid can be used to replace citric acid in the production of soft drinks, sugar confectionery, jams and jellies, and canned products without alteration in manufacturing of formulation techniques, other than reduction in quantity of malic acid used. Advantages of using malic acid are emphasized. VJG

[Gas chromatographic analysis of non-volatile organic acids in several samples of Korean makkuli.]
Cho, D. H.; Shin, Y. T.
Report of the Technical Research Institute of Tax Office 2: 1-7 (1969) [7 ref. Ko, en] [Tech. Res. Inst. of Tax Office, Mapo-ku, Seoul, Korea]

Gas chromatographic analysis of non-volatile organic acids in several samples of makkuli (Korean turbid rice wine) was effected. Succinic acid was the most abundant organic acid (content, 30-40 mg/250 ml). The contents of lactic, citric, and malic acids were respectively trace-224 mg, 0.6-224 mg, and trace-18 mg/250 ml. Citric, malic, and oxalic acids present in the various fermenting starters were converted at least partly to succinic acid rather quickly during the fermentation. KoSFoST

Dark CO_2 fixation by potato tuber tissue.
Clegg, C. J.; Whittingham, C. P.
Phytochemistry 9 (2) 279-87 (1970) [21 ref. En] [Dept. of Botany, Imperial Coll., London SW7, England]

Dark fixation of $^{14}CO_2$ has been observed in whole potato tubers and in freshly cut and aged disks of tuber tissue. The immediate products, due to catalysis by phospho-enol pyruvate carboxylase were malate and aspartate. The further metabolism of these compounds in tuber tissue has been investigated. It was confirmed that the tricarboxylic acid cycle is partially blocked in fresh disks and that it is activated during ageing. Bacterial contamination of disks was shown not to account for CO_2 fixation. AS

On the photosynthetic activity of developing apple fruits.
Clijsters, H.
Qualitas Plantarum et Materiae Vegetabiles 19 (3/4) 329-42 (1969) [13 ref. En, fr, de] [Lab. of Plant Physiology, Res. Sta. of Gorsem, Saint-Truiden, Belgium]

The effect of light on CO_2 and O_2 exchange was described in apple fruits. A photosynthetic activity of the fruit could be demonstrated in this way. During the period of cell growth both fruit photosynthesis and respiration decreased and were found to be of the same order of magnitude. At the moment of ripening, while the climacteric rise of respiration took place, photosynthetic activity remained however constant. The photosynthetic apparatus was found to undergo different changes during ripening. Expt. with fruits, grown on the tree in continuous darkness, showed that light, shining on the fruit, had an effect on the photosynthetic activity as well as on the distribution of malic acid in the apple, but that it had no effect on fruit growth. AS

[Changes in the amount and composition of 'organic acids' anions and mineral cations. Changes in respiration of gooseberry.]
Coic, Y.; Roux, F. le
Comptes Rendus Hebdomadaires des Seances de l'Academie d'Agriculture de France 58 (4) 247-251 (1972) [2 ref. Fr]

Changes in organic acids and mineral cations in gooseberries during their maturation were studied. Results showed that over the period 11 May to 30 June the shikimic acid content (expressed as mg equivalents/100 g fresh material) fell from 2.7 to 0.6, that of quinic acid fell from 0.5 to 0, that of malic acid fell from 13.6 to 9.9 and that of citric acid increased from 6.0 to 17.2 so that the total acid content rose from 22.8 to 27.7. K content fell from 6.05 to 2.3, Ca content from 1.83 to 0.3 and Mg content from 0.9 to 0.3, giving a total drop of from 8.8 to 3.2. The ratio acid anion:cation increased from 2.6 to 8.7 over the period. During maturation the respiratory quotient QO_2 measured at 25°C decreased from 179 to 27/g fresh material and from 215 to 194 per gooseberry. These results agree with those of Whitig, [J. Sci. Fd Agric (1958) 9 244-248] and show that the acids present in the gooseberry are only slightly salified and the rate of salification decreases with maturation. Evolution of the QO_2 is of the non-climacteric type. LA

[Effect of heating of grapes on some constituents of the must.] [A lecture]
Cordonnier, R.
Bulletin de l'Office International du Vin 43 (468) 139-45 (1970) [5 ref. Fr] [Sta. de Tech. Vegetale, Centre de Recherches Agronomiques du Midi, Montpellier, France]

Effect was investigated of heating (30 min at 70°C) of the grapes on some constituents of the musts of Carignane, Cinsaut, Aramon and Grenache varieties. Contents of sugar, malic acid and ammonia N were not affected by the heating; contents of tartaric acid, K and organic N increased, probably as a result of the increased solubility of the substances in solid particles; contents of proteins decreased. Increase in N compounds in the juice was demonstrated by increased biopotential as demonstrated by growth of Saccharomyces cerevisiae var. ellipsoideus. N distribution in pulp and juice was investigated with Carignan; total N present appeared to be about the same in juice and residue; in pulp the N was present mainly in the form of protein. Heating caused increase in total N but decrease in protein N; ammonia N remained constant. JMS

Metabolism of citric and malic acids during ripening of tomato fruit.
Davies, J. N.; Maw, G. A.
Journal of the Science of Food and Agriculture 23 (8) 969-976 (1972) [26 ref. En] [Glasshouse Crops Res. Inst., Rustington, Littlehampton, Sussex, UK]

Tomato fruit at various stages of ripenes of ripeness were injected with ^{14}C-labelled citric and malic acids. The $^{14}CO_2$ evolved by individual fruit was determined over a 72 h period and the fruit then analysed for the incorporation of ^{14}C into sugars, amino acids and individual non-volatile organic acids. In mature green tomato fruit citric and malic acids were found to be metabolised to a comparable extent. Appreciable interconversion occurred together with oxidation to CO_2 and some labelling of glutamic acid and glutamine. In red fruit, citric acid was not as readily oxidised to CO_2 and little conversion to malic acid was observed. On the other hand, malic acid was oxidised to CO_2 and converted to citric acid as rapidly as in green fruit with, in addition, appreciable conversion to glutamic acid. These results are discussed in relation to the changes in concentration of the endogenous acids which take place during the ripening of tomato fruit. AS

[Lactic acid concentrations in Spanish wines.]
Diez de Bethencourt, C. A.
Revista de Agroquimica y Tecnologia de Alimentos 12 (1) 111-124 (1972) [8 ref. Es, de, en, fr] [Inst. de Fermentaciones Ind., Madrid, Spain]

A large number of wine samples from various regions of Spain was analysed for malic and lactic acids, ethanol, sulphite (free and total) and total acidity. Results demonstrated the great variability in the contents of naturally formed lactic acid, and emphasized the difficulty of establishing meaningful legal limits. RM

[Correction of the acidity of musts and wines.] [A lecture]
Dios Morales, R. J. de
Bulletin de l'Office International du Vin 44 (488) 919-922 (1971) [3 ref. Fr]

The Argentine report in the series states that the total acidity of musts varies from 3.5 to 7 g/l. (as tartaric acid) and of wines from 4.5 to 6 g/l. comprised mainly of tartaric and malic acids. The ratio tartaric:malic acid varies from 0.5-0.70 in common and 0.70-1.50 g/l. in quality wines; the pH of musts and wines varies from 3.2-4.2. Acidification is effected by the mixing of grapes and blending of musts and wines respectively. Addition of organic acids is allowed without limits: tartaric acid is usually added to musts and tartaric, metatartaric or citric acid to wines. Deacidification is not necessary in Argentina and is not allowed. JMS

[Influence of a high NO_3 fertilization of grapes on the NO_3 content of the must.] Überträgt sich eine hohe NO_3-Düngung der Reben auf den NO_3-Spiegel im Most.
Dittrich, H. H.; Leidenfrost, E.; Tepe, W.
Wein-Wissenschaft 25 (4/5) 130-32 (1970) [4 ref. De] [Hessische Lehr- und Forschungsanstalt für Wein-, Obst- und Gartenbau, Geisenheim/Rhein., W. Germany]

Effect of addition of 80, 160 or 240 kg N/ha on grapes already fertilized with 120 kg N, 120 kg P_2O_5 and 240 kg K_2O/ha was investigated. The following analyses were carried out: NO_3 content of must by the Rebelein technique; flame photometric determination of K, Na, Ca, Mg and S contents of the ash; Kjehldahl total N content; colorimetric determination of Mn and P contents of the ash; enzymic determination of malic acid according to Boehringen; determination of protein content according to Lowry; amino acids analysis using the Aminomat. Results showed no increase in the NO_3 content of the must, a slight increase in the total N content, and an increase in the malic acid content from 0.611 to 10.5 %. MHW

...ges in citric acid during champagne ...ction.]
...elav, E. S.; Dubinchuk, L. V.; Glonina, N. N.
...ya Vysshikh Uchebnykh Zavedenii, ...evaya Tekhnologiya 1971 (6) 42-44 (1971) [6 ref. Ru] [Vses. Zaochnyi Inst. Pishchevoi Promyshlennosti, USSR]

Fixing of CO_2 by yeasts is an important part of the biosynthetic processes taking place during yeast metabolism. Changes in CO_2 during the production of champagne were studied using labelled CO_2. The yeasts fixed about 0.4% of the CO_2 from the wine must, the CO_2 being then synthesized into a number of different compounds, especially α-ketoglutaric and pyroracemic, malic, succinic, citric, lactic acids, and some amino acids. Increased pressure and concentration of the CO_2 during wine fermentation in hermetically sealed vessels did not induce a more pronounced increase in CO_2 fixation compared with conventional processes. STI

[Cooked taste and the presence of 5-HMF in apple juice. Study with model solutions.]
DriHeau, J.-F.; Prioult, C.
Industries Alimentaires et Agricoles 88 (5) 699-704 (1971) [14 ref. Fr, de, en] [Sta. de Recherches Cidricoles, Centre de Recherches Agronomiques, Rennes, France]

The presence of 5-hydroxymethylfurfural (5-HMF) in (i) commercial apple juices and concentrates, (ii) laboratory prepared red apple juices and (iii) solutions containing specific amounts of different sugars and malic acid were assayed using the colour reaction technique of Collen [Ann. Technol. Agric. (1962) 11 (2) 167-174]. The method is sensitive to ⩾1 mg 5-HMF/l. Of 5 samples of (i), 1 was pasteurized for 25 min at 75°C, and 1 was 5-yr old; 5-HMF contents were 0 and >200 mg/l. respectively, while the remaining 3 samples showed levels of 0, 2, and 4 mg/l. The (ii) samples were prepared from Golden and Locard-Saumon varieties; the Golden type contained no 5-HMF, and the other type contained very little. The (iii) samples comprised either glucose, fructose or sucrose with malic acid; only the solution containing fructose gave any indication of 5-HMF at ambient temp. or on heating to 85°C for 30 min. The results are interpreted as showing that presence of 5-HMF is not an indication of poor organoleptic properties in apple juices. LA

F

[Correction of the acidity of musts and wines.] [A lecture]
Faber, J.
Bulletin de l'Office International du Vin 44 (488) 923-925 (1971) [Fr] [Sta. Viticole de l'Etat, Remich, Luxembourg]

The Luxembourg report in the series states that in Luxembourg only white wines are produced. Musts contain ~6 g/l. tartaric acid and 3-5 g/l. malic acid, with a total acidity of 8-12 g/l. (as tartaric acid); the ratio tartaric acid/malic acid varies considerably with years and grape varieties; the pH varies from 2.8-3.8. Wines contain 1-5 g/l. tartaric acid, malic acid in widely ranging quantities and 0-3 g/l. lactic acid, the pH varies between 3 and 4. Acidification is forbidden by law. Methods of deacidification allowed by law are: addition of a sugar solution to a max. of 20% of the must vol (this method will be permitted only up to 1979 because of new EEC-regulations); addition of $CaCO_3$; double salt treatment; increased malo-lactic fermentation; blending of wines. Apart from wine blending, the treatments are mostly carried out on musts. JMS

content of ciders and wines.]
Fadenko, P. S.; Saenko, N. F.
Sadovodstvo, Vinogradarstvo i Vinodelie Moldavii 26 (7) 28-29 (1971) [Ru] [Proizvodstvennoe Ob'edinenie Sovkhozov-Zavodov, Glavuprvinproma MPP Moldavian SSR, USSR]

It was found that acids present in mash and wine cause corrosion of concrete vessel walls and reduce wine quality. The tartaric acid in cider and wine reacts with concrete to form potassium tartrate, which settles on the walls. If wine is kept in reinforced concrete vessels, the active wine acidity decreases and the contents of Fe, ash, Na and K increase; an odour of H_2S frequently occurs. At present, the vessel walls are coated with a protective layer, consisting of tartaric acid, sulphuric acid and paraffin wax. Walls treated with tartaric acid alone are not suitable for wine or sulphitized cider; moreover, walls treated with tartaric or malic acid cannot be washed easily, and the wine will frequently be spoiled. Treatment with sulphuric acid can produce a plaster which dissolves in the wine; the treatment is also not durable. Paraffin wax has little mechanical durability. Preliminary experiments indicated that Eprosine and a foundation of CHS-04 and VChL-4000 lacquers give good protection. STI

[Fixation of $^{14}CO_2$ in darkness by grapes in anaerobic conditions. II. Fate of ^{14}C during intracellular fermentation.]
Flanzy, C.; Flanzy, M.; Andre, P.; Chambroy, Y.
Annales de Technologie Agricole 18 (4) 307-25 (1969) [17 ref. Fr, en, es, it] [Station de Technologie des Produits Vegetaux, Centre de Recherches d'Avignon, 84-Montfavet, France]

When grapes of the Aledo variety were exposed in the dark to $^{14}CO_2$ in an atm. of 99% Ar for 5 h, the ^{14}C accumulated rapidly in the acids of the Krebs cycle, especially in the malic acid. Evidence for the compartmentalization in plant cells of malic, succinic and citric acids, and for the existence of more than one pathway to ethanol formation is presented. [See FSTA (1969) 1 8J690 for part I.] DJS

[Correcting the acidity of musts and wines.]
Feduchy Marino, E.; Xandri Taguena, J. M.
Bulletin de l'Office International du Vin 44 (479) 64-69 (1971) [Fr]

This is the Spanish report in the series on the topic. Total acidity (as g tartaric acid/l.) of musts and wines varies with the region, from 2.3 to 7.8 for musts and from 3.0 to 9.0 for wines (corresponding pH ranges being 3.5-4.2 and 2.7-3.9). The principal acids occurring in the wine are tartaric, malic, citric, succinic, lactic and acetic. Acidification of wines is necessary in Spain, and is usually effected by addition of tartaric acid, plus ⩽1 g/l. citric acid; addition of $CaSO_4$ is allowed up to a final concn. of 2 g/l.; this does not apply, however, to full-bodied, aged or brandy wines. JMS

[Diffusion of products of anaerobic fermentation of grapes in a liquid medium.]
Flanzy, C.; Buret, M.
Comptes Rendus Hebdomadaires des Seances de l'Academie d'Agriculture de France 56 (7) 422-28 (1970) [1 ref. Fr] [Sta. de Tech. des Produits Vegetaux INRA-CRA du Sud-Est, Montfavet, France]

Grapes held in a sterile liquid medium underwent intracellular anaerobic fermentation, the intensity of which was related to the temp. The rate of diffusion of ethanol, malate, reducing sugars and polyphenols into the medium increased with temp. The first 3 metabolites followed a sigmoidal curve. The diffusion of polyphenols was rapid initially, and then diminished progressively. [See also previous abstr.] HSi

[Fixing of [illegible] by grapes in anaerobiosis]
Flanzy, C.; Buret, M.; Chambroy, Y.
Annales de Technologie Agricole 20 (1) 49-60 (1971) [15 ref. Fr, en, es, it] [Sta. de Tech. de Produits vegetaux, Centre de Recherches d'Avignon, INRA, 84-Montfavet, France]

An aqueous solution of 3-^{14}C malic acid (45 μCi) is injected into 50 Chasselas grapes separated from the stalk. Placed in A at 35°C in the dark, the grapes undergo intracellular fermentation. After 9 h of anaerobiosis, they are pressed. The must and pomace are then fixed independently from each other. Volatile reducing products, released CO_2, reducing sugars, non ketonic organic acids, free amino acids and amino acids of soluble protides in the must are determined reparately or as a group. Radioactivity is found mainly in the organic acids, volatile reducing products and free amino acids. Malate-succinate, malate-ethanol relationships seem to exist as well as a metabolic series consisting of succinate and certain amino acids. A comparison of the results of this test with the results of our experiments on incorporation of $^{14}CO_2$ lead to the assumption of the existence of malate chambers in the grape. AS

Current food additives legislation - Mexico.
Food & Agriculture Organization
Current Food Additives Legislation 1970 (312) 11 (1970) [En] [Rome, Italy]

The resolution confirming the Official Quality Standard for apple juice DGN-F-45-1969 (9 July, 1969) authorizes the use of ascorbic, tartaric, malic, citric or other specific acid as pH adjusters. The product must be free, within the limits of tolerance imposed by the Secretariat of Health and Welfare, of pesticide residues or other harmful substances. VJG

Current food additives legislation - Mexico.
Food & Agriculture Organization
Current Food Additives Legislation 1969 (125) 4-5 (1969) [En] [Rome, Italy]

Official quality standards for fruit preserves, (orange marmalade, peach jam, quince jelly, pineapple jelly and mango jelly) authorize addition of pectin as a gelling agent; citric, lactic, tartaric or malic acid, alone or in combination as pH adjusters; sodium benzoate (max., 0.1% by wt. as benzoic acid in the finished product), sorbic acid or its Na or K salts (max., 0.2% by wt. as sorbic acid in the finished product) and SO_2 (max., 40 ppm in the finished product) as preservative agents; ascorbic acid as antioxidant; sodium citrate and/or potassium citrate (max., 0.2%); and colorants authorized by the Secretariat of Health and Welfare (label statement required). Artificial sweeteners and flavourings are prohibited. Pesticide residues are tolerated in accordance with levels established by the Secretariat. AB

Current food additives legislation - Mexico.
Food & Agriculture Organization
Current Food Additives Legislation 1969 (125) 6 (1969) [En] [Rome, Italy]

Official quality standards for pineapple juice, dated 20 May, 1968 and orange juice, dated 18 July, 1968 authorize addition of any of the following organic acids, alone or in combination: citric, malic, tartaric, ascorbic, or other acids specifically intended to adjust the soluble-solids/titratable acidity ratio. Label statement of amount of ascorbic acid added is required, and this shall not exceed 200 ppm for Grades A and C and 250 ppm for Grade B orange juice. Packaging materials which may impair quality are prohibited and the juices must be virtually free from pesticide residues in accordance with tolerances established by the Secretariat of Health and Welfare. AB

Current food additives legislation - Mexico.
Food & Agriculture Organization
Current Food Additives Legislation 1969 (122) 4-5 (1969) [En] [Rome, Italy]

Official Quality Standards, Dec. 1967, for guava jelly and blackberry jelly and also 13 Feb. 1968 for apple jelly permit the following additives: Pectin; Adjuvants - to make good any natural deficiencies in pectin or acidity, citric, lactic, tartaric and malic acids, and lemon juice alone or in combinaton; Preservatives (max. calculated on finished product) - sodium benzoate (max.: 0.1% by wt. expressed as benzoic acid), sorbic acid or its Na or K salts (0.2% by wt. expressed as sorbic acid) and SO_2 (40ppm); Antioxidants - ascorbic acid; Buffering agents - sodium citrate and/or potassium citrate (max.: 0.2%); Colouring matters authorized by the Secretariat of State of Public Health and Welfare. The addition of flavourings is prohibited. AB

Current food additives legislation -South Africa.
Food & Agriculture Organization
Current Food Additives Legislation 1968 (120) 11-12 (1968) [En] [Rome, Italy]

Government Notice No.R.1522, of 30 Aug. 1968, concerns "Regulations in regard to cider, perry, apple fermented beverage, pear fermented beverage, and orange fermented beverage". Regulation 5 provides that any one or more of the following substances may be added to the above-mentioned beverages (designated as "other fermented beverages") either before, during or after the manufacture thereof; yeasts or harmless yeast nutrients; tartaric, citric ro malic acid; CO_2; activated charcoal; SO_2 or metabisulphite of Na or K - provided that no "other fermented beverage" shall contain SO_2 in excess of 200 mg (of which not more than 50 mg may be in the form of free SO_2)/l. of such beverage; L-ascorbic acid; gelatin, tannin, casein, egg albumen, agar-agar, bentonite, filtering asbestos or activated clay; enzymes; carbonate of Ca, Na or K; caramel; citrates or malates of Ca, Na, or K; anion or cation exchange resins. AB

Whipped topping mixtures.
Fuji Oil Co. Ltd.
British Patent 1 256 053 (1971) [En]

Whipped topping composition contain fats or oils having an mp of ≥10°C, up to 3% phospholipids and an edible surface active agent which is a fatty acid ester of polyglycerol, polyoxyethelene sorbitan, sorbitol, sucrose and a monoglyceride of malic or citric acid. IFT

Studies on roasting changes of proteins. I. Changes of casein and lysozyme during roasting.
Fujimaki, M.; Kato, H.; Hayase, F.
Agricultural and Biological Chemistry 36 (3) 446-425 (1972) [21 ref. En] [Dept. of Agric. Chem., Tokyo Univ., Japan]

The changes occurring in proteins during roasting at 100-300°C were investigated with casein and lysozyme (pure protein containing no carbohydrate, lipid or phosphate). Considerable decreases in wt. and N content occured in casein at 200-250°C, and in lysozyme at 180-220°C. Decomposition of amino acids in both proteins started at 150-180°C. Tryptophan, S-containing, basic and β-hydroxy amino acids were more easily decomposed than acidic, aromatic and alkyl amino acids. Some free amino acids, peptides α-ketoglutaric, malic and tartaric acids and indole were formed from casein under roasting conditions, only alanine from completely dry protein, suggesting formation of free amino acids and associated roasted flavour of foods through ionic cleavage of peptide bonds by protein-bound water. RM

The taste tests of ...
measurement of point of subjective equalities (PSE) on sourness of nine organic acids ...mitted as food additives.]
...ukawa, H.; Saso, H.; Maeda, S.; Ninomiya, T.
...nal of Food Science and Technology (Tokyo) 16 ...-68 (1969) [6 ref. Ja, en] [Central Res. ...Ajinomoto Co. Inc., Kawasaki, Kanagawa, Japan]

Sour taste is mainly associated with the hydrogen ion concn., and to a lesser extent, with the degree of dissociation. From the results of PSE determined by taste tests sourness was more intensive in the order fumaric>tartaric>malic>acetic>succinic> >citric>lactic>ascorbic and gluconic acids. HE

Studies on the utilization of hydrocarbons by microorganisms. XX. Conversion of fumaric acid to L-malic acid by the association of two kinds of yeasts.
Furukawa, T.; Nakahara, T.; Yamada, K.
Agricultural and Biological Chemistry 34 (12) 1833-1838 (1970) [En] [Dept. of Agric. Chem., Fac. of Agric., Univ., Tokyo, Japan]

In order to convert fumaric acid to L-malic acid continuously by hydrocarbon fermentation, the cultivation of Candida utilis IAM 4215 or Pichia membranaefaciens IAM 4122 which have a high fumarase activity was combined with fumaric acid fermentation by Candida hydrocarbofumarica. 40 strains of yeasts were tested for their fumarase activities. P. membranaefaciens IAM 4122 and C. utilis IAM 4215 had high activity. After C. hydrocarbofumarica was incubated in n-paraffin medium for 5 days, fumaric acid produced was converted to L-malic acid by associated culture with P. membranaefaciens IAM 4122 for 4 or 5 days. Yields of L-malic acid based on n-paraffin were 72 and 70% by P. membranaefaciens and C. utilis, respectively. [See Agric. biol. Chem. (1970) 34: 1402 for previous part.] AS

[Viscosity of diluted solution of sodium carboxymethylcellulose containing saccharide and acid constituents.]
Furuuchi, Y.; Takada, S.; Nagasawa, S.
Journal of Food Science and Technology (Tokyo) 15 (12) 553-56 (1968) [10 ref. Ja, en] [Syuko Junior College, Itinoseki, Iwate, Japan]

Effect of sugars and acids on the viscosity of 0.3-1.0% solution of carboxymethylcellulose (CMC-Na) was investigated. Specific viscosity of CMC-Na solution containing sucrose or glucose was much higher than the sum of those of each solution at corresponding concn. On addition of lactic or malic acid, the viscosity of CMC-Na solution decreased with its pH decrease. Such decrease was not observed when the sugars were present in the solution. HE

G

[Effects of kiln temperature on glycerine and organic acid contents of malt from different barley varieties.] Einfluss der Abdarrtemperatur auf die Zusammensetzung des Malzes an Glycerin und organischen Säuren von verschiedenen Gerstensorten.
Gehlhoff, R.; Piendl, A.
Brauwissenschaft 24 (4) 109-10 (1971) [6 ref. De, fr] [Inst. für Tech. Mikrobiol. und Tech. der Brauerei, Weihenstephan, W. Germany]

Studies with 3 barley varieties (Eli, Wisa, Bido) showed that a considerable proportion of the organic acids are formed during the malt production process. Increase in the kiln temp. from 75 to 95° C increased the citrate concn. and decreased the glycerine concn. There were some inter-varietal differences. Malts kilned at 75°C contained the most malate and acetate; the level declined at 85° C, but picked up again at 95°C. It is postulated that at 85° C, inactivation of the enzyme caused a drop in the acid content, and that at 95° C chemical processes occur between the carbohydrates and amino acids,

H

Pan scale.
Halden, H. E.; Storr, M.; Eis, F. G.
Journal of the American Society of Sugar Beet Technologists 15 (4) 312-17 (1969) [1 ref. En] [Spreckels Sugar Co., Woodland, California, USA]

A white scale deposited in the vacuum pan was identified as Ca salts of organic acids such as citric, malic, oxalic, lactic, glycolic, succinic and possibly others (unidentified). Conditions causing scale formation could not be established. Measures for preventing or minimizing its formation include: minimizing soluble lime salts by second carbonation alkalinity at the optimum, use of soda ash when necessary and boiling out pans when any sign of scale appears on sediment pads, which can be detected at fractions of ppm. Very slightly acidified water or versene is recommended for boil-out. RM

The threshold value for physiological action of ethylene on apple fruits.
Harkett, P. J.; Hulme, A. C.; Rhodes, M. J. C.; Wooltorton, L. S. C.
Journal of Food Technology 6 (1) 39-45 (1971) [En]

In fruit picked at different stages of development and stored at 12°C, the threshold concn. of applied ethylene required to cause an increase in respiration decreased as the fruit matured. In young fruits 10 days elapsed between the application of 10 ppm ethylene (for the first 3 days) and an increase in respiration. By contrast, in mature fruit, close to the respiration climacteric, as little as 0.1 to 1 ppm ethylene induced an increase in respiration within a few days. Relatively massive production of ethylene and the development, in disks of peel taken from the fruit, of a malate effect (excess CO_2 produced on addition of malate) occur sometime after increase in respiration. The implications of these results in the control of the respiration climacteric are discussed. AS

[Possibilities of influencing respiration and ripening of pomefruit.] Möglichkeiten zur Beeinflussung der Fruchtatmung und -reifung bei Kernobst.
Henze, J.
Gartenbauwissenschaft 34 (2) 159-87; (3) 189-225; (4) 329-64 (1969) [211 ref. De, en, fr]

[Contd. from preceding abstr.] Factors inhibiting respiration, such as temp., O_2 and CO_2 concn., were also tested. Cox's Orange Pippin and Golden Delicious were stored at 22°C (after initial storage at 4°C) and possible harmful effects of gaseous CO_2, O_2 and N_2 in the storage atm. were studied. Cox's appeared to be very sensitive to changes in gas composition or addition of volatiles; Golden Delicious showed the same tendencies, but they were much less intense. Similar expt. were carried out with storage at 4°C; at the same time, effect of low O_2 concn. (4%) combined with extremely low CO_2 contents (0, 5 or 10%) were tested. For Cox's, an atm. containing a CO_2:O_2:N_2 ratio of 0:4:96 inhibited respiration; this effect was annulled when the fruit was treated with fresh air at 22°C for 6 days after 3 wk at 4°C. CO_2:O_2:N_2 ratios of 5:4:91 and 10:4:86 had a detrimental effect, while 0:0:100 resulted in irreversible disruption of the respiration process and made the fruit inedible. Golden Delicious was much less sensitive than Cox's: atm. with CO_2:O_2:N_2 ratios of 0:4:96, 5:4:91, 10:4:86 and 0:0:100 inhibited respiration to the same extent, but organoleptic and analytical anomalies were found only with 100% N_2 or 100% CO_2. Results for the Glockenapfel were comparable with those of Golden Delicious. [Contd. in following abstr.] JMS

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...artenbauwissenschaft 34 (2) 159-87; (3) 189-225;
(4) 329-64 (1969) [211 ref. De, en, fr]
[Contd. from preceding abstr.] Alexander Lucas pears showed a CO_2 sensitivity similar to that of the Cox's Orange Pippins. An atm. with a CO_2:O_2:N_2 ratio of 0:4:96 had the most favourable effect on respiration inhibition. Other ratios caused damage to the respiration mechanism, resulting in defective taste in the fruit. For all the expt., changes in fruit composition (contents of malic acid, CO_2 production, wt. decrease, respiration losses, soluble DM), consistency of the fruit and palatability are listed. Effect of different amounts of CO_2, O_2 and N_2 on the chemical pathway of the acids in the various apples was also investigated. JMS

[Possibilities of influencing respiration and ripening of pome fruit.] Möglichkeiten zur Beeinflussung der Fruchtatmung und -reifung bei Kernobst.
Henze, J.
Gartenbauwissenschaft 34 (2) 159-87; (3) 189-225; (4) 329-64 (1969) [211 ref. De, en, fr] [Inst. für Obstbau und Gemüsebau, Univ., Bonn, W. Germany]
Expt. were carried out during 1963-1967 to determine to what extent respiration of pome fruits could be varied. James Grieve, Golden Pearmain, Cox's Orange Pippin, Golden Delicious and Glockenapfel apples and Alexander Lucas pears were used. From expt. with paraffin wax coating or lecithin dipping of apples it is concluded that, depending on fruit variety and lecithin concn., O_2/CO_2 equilibrium is established inside the fruit during storage at 4°C, thereby inhibiting respiration and aiding preservation of the fruit. For CO_2-sensitive varieties, such as Cox's Orange Pippin, the CO_2 tolerancy limit may be exceeded, so that transfer of fruit with a high internal CO_2 concn. to higher temp. may initiate rapid spoilage. Attempts were made to intensify respiration by raising the temp. and adding ethylene or volatiles. James Grieve and Golden Pearmain apples and Alexander Lucas pears were stored at 22 °C in an air current (30 l./h) in various atm. with high levels of O_2 and volatiles (ethylene, butyl acetate). Increase of O_2 supply from 21 to 50% produced with James Grieve the same increase in respiration as addition of ethylene to air in concn. of 10^{-3} or 10^{-4}. Combined addition of ethylene (10^{-3}) and butyl acetate (10^{-4}) prolonged the effect of the ethylene for 3 days and showed another increase in respiration after the 12th day. The fruit was then considered ripe. Golden Pearmain showed the same general tendencies as James Grieve. Higher wind speeds also promoted respiration, especially with the Alexander Lucas pear, leading to unfavourable changes in taste. [Contd. in following abstr.] JMS

Malate oxidation by tomato fruit mitochondria.
Hobson, G. E.
Biochemical Journal 116 (4) 20P (1970) [3 ref. En]
[Glasshouse Crops Res. Inst., Rustington, Littlehampton, Sussex, England]

Respiratory oxidation by mitochondria from tomatoes at different stages of ripeness.
Hobson, G. E.
Qualitas Plantarum et Materiae Vegetabiles 19 (1/3) 155-65 (1969) [34 ref. En, fr, de]
[Glasshouse Crops Res. Inst., Littlehampton, Sussex, England]
Mitochondria were isolated from tomatoes at different stages during ripening using a slightly modified method of Ku et al. [Pl. Physiol. (1968) 43: 883-87]. Oxidative ability was measured polarographically using the method of Wiskich et al. [Pl. Physiol (1964) 39: 321-22] and protein content of the mitochondrial suspensions determined by the method of Thompson and Morrison as modified by Biale et al. [Physiologia Pl. (1957) 10: 48-63]. Oxidation rates of mitochondria and their respiratory control and ADP to O_2 uptake ratios reached a max. with ripeness and declined with onset of senescence. Thiamine pyrophosphate increased oxidation rate to malate and α-ketoglutarate at all stages and prevented any inhibition due to oxalo-acetate. Particles from unevenly ripened fruit had the characteristics of mature green fruit and overripe fruit at the respective coloured patches, and those from fruit with the dominant "never ripe" allele were comparable with fruit undergoing normal maturation. PEG

The oxidation of malate by mitochondria from normal and abnormal tomato fruit.
Hobson, G. E.
Phytochemistry 9 (11) 2257-63 (1970) [29 ref. En]
[Glasshouse Crops Res. Inst., Rustington, Littlehampton, Sussex, UK]
An improved method of isolation of mitochondria from the outer walls of tomato fruit during maturation and ripening has been developed and the oxidation of malate by particles so obtained studied. When particles from fruit showing some external red colour were tested, especially in the presence of thiamine pyrophosphate or sodium glutamate + pyridoxal phosphate, either of which increased the rate of malate oxidation considerably, a show period of inhibited oxidation interposed between the ADP-stimulated rate (state 3) and the true ADP-limited rate (state 4) was found. Mitchondria from both the green and the red areas of non-uniformly ripened ('blotchy') fruit behaved similarly. In any set of conditions the extent of the inhibition was proportional to the amonut of ADP available to the mitchondria. It is suggested that the inhibition is due to an accumulation of oxalo acetate and that addition of any substance capable of lowering its concn. increases the rate of malate oxidation. AS

The relationship between ethylene and the synthesis of RNA and protein in ripening apples.
Hulme, A. C.; Rhodes, M. J. C.; Wooltorton, L. S. C.
Phytochemistry 10 (4) 749-756 (1971) [14 ref. En]
[Food Res. Inst., Colney Lane, Norwich, Norfolk, UK]
The stimulation by C_2H_4 of the respiration of whole fruits and peel disks prepared from them was investigated using Worcester Pearmain and Cox's Orange Pippin apples. Exposing preclimacteric fruit for 3 days to 40-60 ppm C_2H_4 and then returning the fruit to air, triggered off both respiration climacteric and autonomous C_2H_4 production. Incorporation of ^{14}C-uridine into RNA fractions of peel disks rose to a peak during very early stages of C_2H_4 induced climacteric followed by increased ^{14}C-valine incorporation into protein, while a malate decarboxylating system (malic enzyme, pyruvate decarboxylase, alcohol dehydrogenase) develops in the ripening fruit. RM

The effect of ethylene on the respiration, ethylene production RNA and protein synthesis for apples stored in low oxygen and in air.
Hulme, A. C.; Rhodes, M. J. C.; Wooltorton, L. S. C.
Phytochemistry 10 (6) 1315-1323 (1971) [7 ref. En] [Food Res. Inst., Colney Lane, Norwich, NOR 70F, UK]

A comparison is made between the respiration rate and ethylene production of the whole fruit and the respiration rate, ethylene production, incorporation of ^{14}C-uridine into an RNA fraction and of ^{14}C-valine into a protein fraction of peel disks prepared from the fruit from Bramley's Seedling apples stored at 12°C in air and in 3%O_2. Results show that the respiration and ethylene production of the whole fruit is closely reflected in the behaviour of the peel disks in air, in low O_2 and on transfer from low O_2 to air. Ethylene appears to be the key to the increased rate of respiration and the other parameters including the development in the disks of a malate decarboxylating system (the malate effect) which appears to be a coupled system involving malic enzyme, pyruvate decarboxylase and alcohol dehydrogenase($NADPH_2$-dependent.). While exogenous ethylene has a temporary stimulatory effect on the various systems investigated when applied in 3%O_2, autostimulation of ethylene production with attendant physiological action does not appear possible in low O_2. Both production and physiological action of ethylene appear to require relatively high concn. of O_2 for their full operation. AS

I

[Seasonal changes in the major components of kaki fruits.]
Inaba, A.; Sobajima, Y.; Ishida, M.
Scientific Reports of the Kyoto Prefectural University, Agriculture [Kyoto-Furitsu Daigaku Gakujutsu Hokoku, Nogaku] 23, 24-28 (1971) [22 ref. Ja, en] [Lab. of Pomology, Fac. of Agric., Kyoto Prefectural Univ., Japan]

Concentrations of sugars, starch, organic acids, ascorbic acid, soluble tannin, protein and soluble N, were determined in (i) Fuyu and (ii) Hiratanenashi kaki fruits during the period from flowering to ripening. Glucose and fructose concn. in both (i) and (ii) increased gradually until ripening, while sucrose concn. remained low. 3 wk after flowering, starch content in (ii) fell to a negligible level, while (i) showed an increase. Malic acid concn. in both (i) and (ii) showed an increase 3 wk after flowering, thereafter decreasing in both until onset of ripening, and tending to increase in (i) during ripening. Citric acid content of both (i) and (ii) decreased until the mid-stage of growth and then increased until ripening. Ascorbic acid content decreased steadily during development except for a sharp increase in about mid-September. Soluble tannin, protein and soluble N all reached a max. at about 3 or 4 wk after flowering. [From En. summ.] AA

Seasonal changes in the concentration of sugars and organic acids in peach fruits.
Ishida, M.; Inaba, A.; Sobajima, Y.
Scientific Reports of the Kyoto Prefectural University, Agriculture [Kyoto-Furitsu Daigaku Gakujutsu Hokoku, Nogaku] 23, 18-23 (1971) [19 ref. En, ja] [Lab. of Pomology, Fac. of Agric., Kyoto Prefectural Univ., Japan]

A study was made of the quantitative changes in the concentration of sugars and organic acids in peach fruits thoughout the growing season. The following 3 varieties of peach were used for the experiment in 1969: "Senshowase", early maturing variety; "Okubo", middle maturing variety; and "Hakuto", late maturing variety. Fruits were picked at weekly intervals from full bloom to maturity; samples were placed in polyethylene bags, sealed and stored at -20°C until analysed. The initial level of malic and citric acids was low; it increased steadily with growth reaching a maximum in mid-season and then declined steadily as the fruit matured. Malic acid was the most prominent acid during fruit growth in the 3 varieties. Starch content increased rapidly during the first few weeks of growth reaching a maximum about May 6-13th; however, it then decreased and disappeared later in the season. Glucose and fructose content increased slowly until mid season, reaching a maximum at the onset of pit-hardening, but then increased rapidly during the last 2 wk of maturation. AA

J

Analogue computer model for predicting chemical and physical properties of selected food materials.
Jahbari, A.; Mohsenin, N. N.; Adams, W. S.
Transactions. American Society of Agricultural Engineers 14 (2) 319-325 (1971) [17 ref. En] [St. Univ., University Park, Pennsylvania, USA]

2 mathematical models were developed for apples during storage and for animal muscle post mortem, based on the kinetics of chemical reactions which take place inside the products. The actual systems were simulated using these models on an analogue computer, and were capable of predicting some physical and chemical properties with an accuracy of ≥80%, provided initial values of these properties were known. The models were variety and species dependent. The model for apples predicted the change with time of starch, sucrose, glucose, fructose, malic acid, pyruvic acid, protopectin, soluble pectin, respiration rate and total CO_2 output in storage under various storage atm. (O_2 and N_2) and temp. (1, 4, 5, 10°C). The model for muscle predicted the change with time of creatine phosphate, glycogen, lactic acid, ADP, ATP, pH and deformation post mortem under various storage temp. (3, 17, 37°C). RM

Improving white bread via flavour additives.
Jackel, S. S.
Bakery Production and Marketing 5 (6) 120 (1970) [En] [Quality Bakers of America Cooperative, Inc., 120 W. 42nd St., New York, New York 10036, USA]

Addition of compounds to improve the flavour of white bread and hence increase consumption, is discussed. Such compounds, including acetic, lactic, butyric, propionic, pyruvic, citric, fumaric and malic acids, spices, enzyme-active soy and malt products, sesame seeds and a variety of artificial flavours, are briefly considered. PEG

[Formation of tartaric and malic acid in grapes, must and wine.]
Janky, F.
Borgazdasag 20 (1) 35-38 (1972) [9 ref. Hu]

Results are tabulated and explanations advanced for changes in tartaric acid (determined photometrically and as potassium hydrogen tartrate) and malic acid (aqueous lanthanum nitrate method) contents of 10 wines at early and late stages in the maturing process. TRANS

[Current problems in wine analysis.] Aktuelle Probleme der Weinanalytik. [A lecture]
Junge, C.
Deutsche Lebensmittel-Rundschau 66 (11) 374-79 (1970) [29 ref. De] [Max von Pettenkofer-Inst., Bundesgesundheitsamtes, 1 Berlin 45, W. Germany]

Problems discussed in this lecture include: practical realization of the theory and principle of an analytical method, with reference to determination of sulphate in wines and grape juices by various techniques; use of sorbitol content as means of determining adulteration of grape wine with apple wine, particularly by enzymic methods; enzymic methods of malic and citric acid determination in wine; determination of sulphurous acid in wine; and determination of preservatives in wine. HBr

K

[Analysis of authentic fruit juices for 1968.] Analysen authentischer Fruchtsäfte des Jahrganges 1968.
Kain, W.
Mitteilungen: Rebe, Wein, Obstbau und Früchteverwertung 19 (5) 372-83 (1969) [18 ref. De, en, fr, es] [Landwirtschaftliche-chemische Bundesversuchsanstalt, Vienna, Austria]

Results, primarily in tabular form, are given of chemical analysis of 3 blackcurrant juices, 1 redcurrant juice, 12 apple juices, 1 pear juice, and 2 fruit juice mixtures (60% apple + 40% pear juice) of Austrian origin, produced during 1968. Analysis was for the most part in accordance with methods of the International Fruit Union and the Office International du Vin. Analytical data listed include density, total sugars, sugar-free extract, non-volatile acids, volatile acids, citric acid, pH, phosphate, alkalinity of ash (by 3 different methods), and I reduction capacity, Grading on organoleptic characteristics is also given. JMS

[Analyses of authentic fruit juices of 1970 vintage.] Analysen authentischer Fruchtsäfte des Jahrganges 1970.
Kain, W.; Vleck, G.
Mitteilungen: Rebe, Wein, Obstbau und Früchteverwertung 22 (4) 279-283 (1972) [2 ref. De, en, fr, es] [Landw.-chem. Bundesversuchsanstalt, Vienna II, Austria]

25 samples of 1970 authentic Austrian raspberry-, sweet cherry-, blackberry- and currant-juices were analyzed organoleptically and by colorimetric absorbance measurements at 525 nm, chromatography of the acids, and determination of extract, sugar, acid (including malic and citric), pH, ash, P_2O_5, and ash alkalinity values. Only a small number of the juices failed to meet the requirements of the Austrian Codex Alimentarius, particularly due to the high malic acid content of some currant-juices. OA

Nonenzymatic browning in model systems containing sucrose.
Karel, M.; Labuza, T. P.
Journal of Agricultural and Food Chemistry 16 (5) 717-19 (1968) [7 ref. En] [Dept. Nutrition & Food Sci., Inst. Technol., Cambridge, Massachusetts 02139, USA]

Expt. were performed on the browning of model systems containing carbohydrates, lipids and proteins. The systems had been freeze- dried, followed by humidification to the desired relative humidities (RH). As expected substantial browning occurred in the system containing glucose. However, the systems containing organic acids and sucrose, the latter being the only added carbohydrate, also browned considerably even at low RH. Addition of protein reduced the rate of browning, especially at low RH. From these results the authors conclude that in model systems containing sucrose and organic acids (e.g. malic or citric acid) at low RH, acid-catalysed hydrolysis of sucrose can occur, the reducing sugars so formed participating in non-enzymatic browning reactions. When acid is lacking the system is stable and does not brown. Protein acts as a buffer and prevents browning. JA

[Chemical studies on corrosion of canned foods. I. Detinning of canned orange juice drink using monosodium fumarate as an acidifying agent.]
Kakizaki, K.; Mori, M.
Canners' Journal 48 (7) 607-13 (1969) [8 ref. Ja, en] [Res. Lab., Canners Association of Japan, Hodogaya-ku, Yokohama, Japan]

Sn content of canned orange juice with and without the addition of monosodium fumarate (MSF), was determined periodically polarographically. Orange juice containing MSF showed a rapid increase in Sn content compared with orange juice with added citric or malic acid. Detinning action of MSF was more pronounced at an elevated temp. and the Sn concn. in the juice exceeded 150 ppm after a short period of storage at 55°C. Maleic and α-ketoglutaric acid also showed strong corrosive action, while tartaric, succinic and quinic acids were mildly corrosive. The method of predicting the date when Sn concn. would exceed 150 ppm was discussed. NA

Analytical problems with fruit products.
Kefford, J. F.
Fruit World & Market Grower 71 (4) 14-20 (1970) [9 ref. En] [Div. of Food Preservation, CSIRO, Ryde, N.S.W., Australia]

Analytical methods used for determining natural fruit content in citrus products are discussed. The following index constituents are used: inorganic compounds K, P and N determined by flame photometry in a combined formula (method suffers from normal wide range of concn. and ease of adulteration, e.g. with specially prepared orange ash sugar); more refined methods use an inverse relation between inorganic and ethanol insoluble P as % total P (no figures given); amino acid content by formol titration (adulteration with glycine can be detected by qualitative thin layer chromatography, with protein hydrolysate by determining ratio of γ-aminobutyric acid to leucine-isoleucine concn.). Individual compounds used as quantitative index include serine (average content, whole orange, 0.192 mg/g), betaine, nicotinic acid (average, 0.29 mg/100 ml juice, confidence limit ±0.14 mg/100 ml), a combined nicotinic acid inositol index (concn. of orange in units of 18° Brix juice = 2.20 nicotinic acid + 0.0025 inositol), total polyphenols, malic acid in lemon juice (added apple juice detected by UV Spectrum and paper chromatography, authenticity of lemon juice established by a formula combining citric acid, amino acid, malic acid and polyphenol content not affected by processing variables or addition of preservatives), carotenoid pigments. Adulteration of juices by peel and rag is detected by chloramine value, ratio of chloramine to formol value pectin content (by pentose equivalent) or 3',4',5,6,7-pentamethoxyflavone. Use of limonin as an index compound is in process of investigation. RM

[The effect of some organic calcium salts on the kinetics of sucrose crystallization.]
Kharin, V. M.; Dobromirova, V. F.
Izvestiya Vysshikh Uchebnykh Zavedenii, Pishchevaya Tekhnologiya No. 2, 168-169 (1972) [4 ref. Ru] [Voronezhskii Tekhnologicheskii Inst., USSR]

Sucrose crystallization was studied in supersaturated aqueous solutions containing acetate, tartrate, succinate and calcium malate at temp. of 50°C and mixing speed of 500 rev/min. Organic calcium salts retarded sucrose crystallization, reduced the speed of formation of crystallization nuclei and of crystal growth. The formation of nuclei was inhibited to a greater extent than crystal growth; consequently the number of crystals at the end of crystallization was smaller and the crystals bigger than pure sucrose crystals. Results of the study permit computation of the mass transfer coeff., the crystal diam. and their number/g of crystalline sucrose at the end of the crystallization process. STI

Effect of day temperature and light intensity on concentration of malic and tartaric acids in Vitis vinifera L. grapes.
Kliewer, W. M.
Journal, American Society for Horticultural Science 96 (3) 372-377 (1971) [26 ref. En] [Univ. of California, Davis, USA]

The concn. of malic and tartaric acids in fruits from 'Cardinal' and 'Pinot noir' vines grown in phytotron rooms were negatively correlated with fruit maturity (°Brix). The rate of decrease of both acids was dependent on temp. and cultivar, but relatively independent of light intensity. Curvilinear regressions (hyperbolas) best described the decrease of malic and tartaric acids in the fruits with the former acid always decreasing at the faster rate. Part of the decrease of tartaric and malic acids in fruits during ripening was attributed to formation of salts of these acids. The concn. of monobasic salts of malic and tartaric acids were usually higher in fruits grown under low light intensity than at high intensity. Mono- and di-basic tartrates and dibasic malate were present in higher concn. in grapes ripened at 30° than at 20°C; however, the reverse was true for monobasic malate salt. The level of dibasic malate and tartrate salts in fruits ripened at 30° increased with fruit maturity, but the concn. of these salts in berries ripened at 20° varied relatively little as ripening progressed. AS

Effects of day temperature and light intensity on growth and composition of Vitis vinifera L. fruits.
Kliewer, W. M.; Lider, L. A.
Journal, American Society for Horticultural Science 95 (6) 766-769 (1970) [23 ref. En] [Univ. of California, Davis, USA]

3-yr-old 'Cardinal' and 'Pinot noir' vines were grown from veraison to fruit maturity in a stationary and rotating phytotron at high (30°C) and low (20°C) day temp. in combination with both high (>2500 foot candles) and low (<1200 foot candles) average light intensities. Night temp. (6 p.m. to 6 a.m.) was 15°C in all treatments. Berries were collected at weekly intervals and analysed for various constituents. Low temp. usually resulted in increased berry wt., total acidity, and malate, and in decreased pH, arginine, proline, and total N in the berry juices, as compared to fruits grown at high temp. The concn. of total soluble solids and tartrate in the fruits generally did not significantly differ with temp. Low light intensity at both high and low temp. generally resulted in reduced berry wt., total soluble solids, pH, and proline, and in increased levels of total acidity, malate, arginine, and total N in the berry juices compared to grapes grown at high light intensity at the same room temp. The concn. of arginine was highly correlated with the level of total N in the fruits of both cultivars. AS

Effect of temperature on the composition of grapes grown under field and controlled conditions.
Kliewer, W. M.
Proceedings, American Society for Horticultural Science 93: 797-806 (1968) [23 ref. En] [Univ. of California, Davis, USA]

Several varieties of Vitis vinifera L., were grown under field conditions (direct sunlight) or in a sunlit phytotron at controlled temp. of 68°F day (6 a.m. to 6 p.m.) and 59° at night. 'White Riesling' fruits ripened at a faster rate in the phytotron than under field conditions, while 'Petite Sirah' fruits ripened at approx. the same rate in both field and phytotron. The lower temp. in the phytotron compared to that in the field was reflected by higher total titratable acidity and lower pH in fruits ripened in the phytotron. In this latter environment, concn. of tartaric acid and malic acid in ripe 'Petite Sirah' and 'White Riesling' fruits were 2-3 times greater than in field fruits, and % of tartrates and malates present as free acid were about twice as great. Generally, malates accounted for a greater % of total titratable acidity than did tartrates in both field and phytotron fruits. But % of total titratable acidity due to tartrates increased, and that due to malates decreased, with degree of fruit ripeness. % of total titratable acidity due to malates was greater in phytotron fruits than in field fruits at the same degree of maturity. Total number of degree days recorded between veraison and maturity of 'Petite Sirah' and 'White Riesling' fruits form vines grown under field conditions was 2-3 times greater than that required for fruit grown in the phytotron. AS

[Studies on flavour constituents in various foodstuffs. I. Flavour constituents of Chinese quince.]
Kim, Y. S.; Lee, S. W.; Lee, K. R.; Kim, K. S.; Cho, S. Y.; Lee, J. H.
Korean Journal of Food Science and Technology 3 (3) 163-167 (1971) [10 ref. Ko, en] [Dept. of Food & Nutr., Coll. of Home Economics, Yeung Nam Univ., Taegu, S. Korea]

Flavour constituents of Chinese quince, such as polyphenols, amino acids, sugars and organic acids, were surveyed. The results are as follows. The major moiety of the polyphenol constituents was catechin, leucoanthocyanin, and associated tannins. Amino acids mostly consisted of aspartic acid, glutamic acid, arginine and β-alanine. Citric and malic acids were the main organic acids. Sugars detected were glucose, fructose, sucrose and xylose. When compared with apple and pear the total amount of amino acids was similar, sugars were half to one third less, the total amount of polyphenol constituents increased 20-50 times and organic acids 3-5 times. This indicates that the origin of the rough and acidic taste in quince may be due to the high levels of polyphenols and organic acids. AS

Effect of nitrogen on growth and composition of fruits from 'Thompson Seedless' grapevines.
Cliewer, W. M.
Journal. American Society for Horticultural Science 96 (6) 816-819 (1971) [16 ref. En] [Univ. of California, Davis, USA]

Growth, yield, and composition of 'Thompson Seedless' fruits from 4-yr-old vines growing in a perlite-vermiculite mixture and irrigated with half-strength Hoagland nutrient solution modified to contain 0, ½, 1, 2, 4, or 8 mM NO_3 were studied. Vines grown without N added to tap water produced no fruits. Number of clusters/vine and number of berries/cluster were significantly less for vines grown with ½ or 8 mM NO_3 than for vines which received 1, 2, or 4 mM NO_3. Wt., pH and malate level of berries increased with increasing levels of NO_3 in the nutrient solution. The concn. of arginine in berry juice increased linearly with increasing levels of NO_3 from ½ to 4 mM, and then remained relatively constant, with about a 12-fold increase between the lowest and highest NO_3 treatments. A second-degree quadratic equation best described this relationship with a correlation coeff. of 0.95. The level of proline, however, continued to increase between ½ and 8 mM NO_3 with about a 4-fold overall increase. The concn. of proline in the juice of grapes at harvest was much more sensitive to level of ripeness (° Brix) than to N treatment, whereas the opposite relationship was true for arginine. The arginine levels in fruits grown with ½-8 mM NO_3 increased 9-20-fold when compared at the same stage of ripeness (° Brix). Total soluble solids, total acidity, and tartrate in berries were not significantly affected by N treatment. AS

Legume taste improvement.
Koch, K. H.
United States Patent 3 660 111 (1972) [En]

The taste and smell of legumes such as peanuts and soya beans are improved by treatment with aqueous solutions of ≥2 acids taken from the group of malic, lactic, tartaric and citric. IFT

Metabolic changes induced by sprout inhibiting dose of γ-irradiation in potatoes.
Kodenchery, U. K.; Nair, M. P.
Journal of Agricultural and Food Chemistry 20 (2) 282-285 (1972) [21 ref. En] [Biochem. & Food Tech. Div., Bhabha Atomic Res. Centre, Trombay, Bombay 85, India]

Respiration studies after irradiating potatoes at doses of 0, 5, 10, 25, 50, 100, 200, and 500 krad showed max. CO_2 output at 10 krad except at higher doses like 200 and 500 krad. Respiratory quotient was 1 in all cases. A 25% increase in starch phosphorylase noted 2 h after irradiation persisted even at 24 h. But in the case of 500 krad, ~10% inhibition was observed at 24 h. A 12% increase in reducing sugar content was obtained at 10 krad. Incorporation of 2-^{14}C-acetate into organic acids at 4 and 24 h after irradiation revealed that radioactivity in major organic acids, citric and malic, was much higher at 4 h in irradiated sample, and at 24 h the radioactivity was less than that in control. Studies of free amino acids showed an increase in aspartic acid, asparagine, threonine, serine, alanine, isoleucine, leucine, lysine, and arginine, 24 h after irradiation. A decrease was observed in the case of glutamic acid, proline, methionine, and phenylalanine. Radioautography of free amino acids after 2-^{14}C-acetate incorporation confirmed the above observations. AS

[The dynamics of accumulation of organic acids during grape ripening.]
Kozenko, E. M.
Izvestiya Vysshikh Uchebnykh Zavedenii, Pishchevaya Tekhnologiya No. 2, 21-24 (1972) [5 ref. Ru] [Kubanskii Ordena Trudovogo Krasnogo Znameni Sel'skokhozyaistvennyi Inst., USSR]

The dynamics of accumulation of organic acids in wine grapes (tartaric, malic, citric, succinic and other acids) obey, during growth and ripening, laws analogous to the dynamics of titratable acidity. A preliminary forecast of changes in the tartaric and malic acid contents in grapes during ripening may be achieved using an empirical equation which characterizes the dynamics of titratable acidity. The ratio of different organic acids in grapes depends on the variety, ecological conditions and structure composition of the grapes. STI

Physiological and chemical studies of chilling injury in pepper fruits.
Kozukue, N.; Ogata, K.
Journal of Food Science 37 (5) 708-711 (1972) [14 ref. En] [Lab. of Processing & Physiol. of Horticultural Products, Coll. of Agric., Univ. of Osaka Prefecture, Sakai, Osaka, Japan]

Physiological effects of low temperature (1-6°C) on pepper fruits were studied during and after exposure for various periods. The CO_2 production of the fruits stored at low temperature increased abnormally after transfer to 18°C. There was an accumulation of α-keto acids in chilled fruits: fumaric, succinic, citric and malic acids were detected and malic increased remarkably during low temperature storage. Using paper chromatography, chlorogenic acid was found to be a main phenolic substance in the pepper seeds; its content increased immediately after exposure of the peppers to low temperature and decreased rapidly during subsequent cold storage. The content of shikimic acid in chilled seeds showed a similar tendency to that of chlorogenic acid; phenylalanine ammonia-lyase (PAL) activity increased rapidly after 2 days' cold storage, then decreased sharply; tyrosine ammonia-lyase (TAL) activity was fairly low compared with PAL activity. IFT

[Food acids and their use in the production of preserves.] Genussäuren und ihre Anwendung bei der Konservenherstellung.
Kuhnert, P.
Industrielle Obst- und Gemüseverwertung 56 (13) 355-358 (1971) [De] [Firma Joh. A. Benckiser GmbH, Ludwigshafen/Rhein, German Federal Republic]

A review is given of the current commercial fruit acids: acetic, lactic, citric, malic, tartaric, fumaric and gluconic acid. Their main characteristics (formula, mol. wt., mp, pH of a 1% solution, dissociation constants, solubility, taste and trade forms) are tabulated. Possible uses (correction of taste, blanching and bleaching, interim storage, wetting, hardening of fruit, preservation) and dosage and aspects of food legislation are discussed. Levels of acids permitted as additives in different fruit and vegetable products in W. Germany are tabulated. JMS

L

[Research on L-malic acid degradation by non-proliferating lactic acid bacteria isolated from wines.]
Lafourcade-Lafon, S.
Annales de Technologie Agricole 19 (2) 141-54 (1970) [7 ref. Fr, en, it, es] [Inst. d'OEnologie de Bordeaux, 33-Talence, France]

The degradation of L-malic acid by some lactic acid bacteria (Streptobacterium, Lactobacillus, Pediococcus Leuconostoc) isolated from wine was studied in a synthetic medium free from nitrogenous substances and containing no hydrocarbon source other than L-malic acid. These conditions prevented cell proliferation, and hence activity viz-a-viz the substrate was almost entirely due to the malic enzyme potential which the cells possess. Optimum conditions for L-malic acid degradation were determined in relation to pH (optimum 3.5-4), temp. (30°C), alcohol concn. (11-14°C), SO_2 content (<20 mg/l.) and other factors. The results provide a means of developing a more efficient method for indicing malo-lactic fermentation in wines. HSi

[Correction of the acidity of musts and wines.] [A lecture]
Laszlo, I.; Macici, M.
Bulletin de l'Office International du Vin 44 (488) 913-916 (1971) [Fr] [Inst. de Recherches Viti-Vinicoles, Valcea Calugareasca, Roumania]

The Roumanian report in the series states that in musts the principal acids are tartaric acid (3-8 g/l.) and malic acid (2-6 g/l.); total acidity varies from 6-10 g/l. (as tartaric acid), of which 2% is citric acid; and pH varies from 3-3.5. Wines contain: tartaric acid (1-5 g/l.), malic acid (0-4 g/l.), citric acid (0-1 g/l.), succinic acid (0.4-1.4 g/l.), lactic acid (0.4-0.8 g/l.) and acetic acid (max. 1.2 g/l. in white and 1.5 g/l. in red wines). The total acidity (as tartaric acid) is 6-8 g/l. in white and 5-6.5 g/l. in red wines; pH values vary from 2.8-4.3 with an average >3.5. Acidification, not often necessary, is effected mostly by blending; addition of tartaric acid or citric acid is allowed to max. 0.75 g/l. Deacidification is effected by the mixing of grapes and stimulation of the malo-lactic fermentation; cold treatments are allowed to reduce the total-acidity. JMS

Production of beet juice as a potential source of vitamins and minerals.
Lee, C. Y.; Downing, D. L.
Food Product Development 4 (4) 44-45 (1971) [6 ref. En] [Dept. of Food Sci. and Tech., St. Agric. Expt. Sta., Cornell Univ., Geneva, New York, USA]

Methods of processing beet juice were studied. Size graded beets were cooked in boiling water and juice extracted from ground beets by a hydraulic press using a press cloth and 1-1.5% Keycel press aid. The juice was acidified to pH 4.3-4.7 with citric, malic or lactic acid, and sugar and/or salt was added. The juice was then canned and heated for 30 min at 250°F and stored for 5 months at 65°F. Juice yield from unpeeled Size 1 and 2 beets was 71%, peeling reduced the yield to 44%. Panel tests showed no difference in preference for the juice extracted from unpeeled or peeled beets. Citric acid and salt treatment of the juice were preferred to malic or lactic acid treatments. Addition of sugar to the juice did not improve the panel scores. AH

[Inhibitors for the protection of chromium-plated sheet metal against corrosion.]
Levyanto, S. L.; Putilova, I. N.
Konservnaya i Ovoshchesushil'naya Promyshlennost' 1971 (9) 13-14 (1971) [Ru] [Vses. Nauchno-issled. Inst. Konservnoi i Ovoshchesushil'noi Promyshlennosti, USSR]

The effect of various corrosion-inhibitors on sheet metal coated with a 0.05 μm layer of chromium oxide was tested under laboratory conditions. The metal was immersed for 7 days in various solutions at 20°C: 3% acetic acid; 3% NaCl; 2.5% malic acid; 2.5% citric acid; and 3% lactic acid. The corrosion-inhibitors used were: 0.1% sorbic acid; 0.05% ascorbic acid; 0.05% agar; 1% edible gelatin; 0.1% citric acid; 0.5% tannin; and 0.2% lysine HCl. The sample surface and solution vol. corresponded to the size of a No. 3 can (GOST 5981-62). The efficiency of the inhibitor was expressed as the % reduction in the corrosion rate compared with the control without inhibitor. From the results, given in tabular form, the best protection was offered by the gelatin and agar or their mixtures with ascorbic or sorbic acids. STI

Changes in organic acid profiles during thermal processing of spinach puree.
Lin, Y.-D.
Dissertation Abstracts International. Section B. The Sciences and Engineering 31 (11) 6679: Order no. 71-11444 (1971) [En] [Univ., Amherst, Massachusetts, USA]

Deaerated spinach puree was flushed with N_2 and sealed in TDT tubes divided into batches and processed with an $F_0 = 4.9$ at temp. in the range 240-300°F with 10°F increments. Analyses after processing and after storage for 3 months at 75°F in the dark were carried out using an Automatic Organic Acid Analyzer and paper chromatography. Acids identified in fresh and processed puree were acetic, formic, fumaric, lactic, succinic, α-ketoglutaric, pyrrolidone-carboxylic, malic, citric, and oxalic. HTST processing causes the least change in colour, pH, and organic acid concn. In stored puree, some acids disappeared, some increased, and new ones were formed. HTST-processed samples showed greater colour degradation during storage. Amount of acetic acid and pyrrolidone-carboxylic acid, associated with other quality parameters, serves as an index of spinach puree quality. An optimum plateau occurred at ~270°F, in terms of the quality parameters evaluated, and a simple method for glutamine analysis was developed. GLS

[Correction of the acidity of musts and wines.] [A lecture]
Loinger, C.; Radomiselsky, M.
Bulletin de l'Office International du Vin 44 (488) 916-919 (1971) [Fr]

The Israeli report in the series states that in musts the principal acids are tartaric acid (3-5 g/l.), malic acid (0.5-2.5 g/l.) and citric acid (<0.5 g/l.); the total acidity varies from 4-8.5 g/l. (as tartaric acid), the ratio tartaric acid/malic acid varies from 0.9-1.1 and the pH varies from 3.20-3.85 with an average of 3.60. Wines normally contain tartaric acid (1-2 g/l.), malic acid (0-3 g/l.), citric acid (0.3-1.2 g/l.), succinic acid (0.3-1.3 g/l.) and lactic acid (0.5-1.5 g/l.); the total acidity (as tartaric acid) varies from 3.5-6 g/l., the ratio tartaric acid/malic acid from 0.3-5.3 and the pH from 3.30-3.95. Acidification is effected by blending, addition of acids is not allowed. Deacidification, though seldom practiced, is done by blending or addition of $CaCO_3$. JMS

The organic acid composition of apple juice and ...es.]
...harashvili, G. I.
...modelie i Vinogradarstvo SSSR 30 (5) 24-26 (1970) [3 ref. Ru] [Ordena Lenina Inst. Biokhimii Imeni AN Bakha AN SSSR, USSR]

Different methods for producing apple juice and their effect on the content and composition of organic acids in the juice and wine were compared. On passing the juice through ion exchange columns a large amount of glucose was oxidized in the presence of Fe to gluconic and glucuronic acids. This effect was suppressed by ether extraction and separation of the acid mixture by TLC. 12 organic acids were found in the juice and 13 in wine, of which oxalic, quinic, chlorogenic, citric, malic, glycolic, malonic, caffeic, succinic and fumaric acids were identified. Malic, oxalic and quinic acids predominated in the juice. On fermentation lactic acid was formed and the concn. of succinic acid increased. Phenolic acids can lead to the formation of unpleasant quinones; this can be prevented by sulphurization or addition of ascorbic acid. STI

Studies on variation in tin content in canned mango nectar during storage.
Mahadevaiah, M.; Gowramma, R. V.; Setty, G. R.; Sastry M. V.; Sastry, L. V. L.; Bhatnagar, H. C.
Journal of Food Science and Technology (Mysore) 6 (3) 192-96 (1969) [11 ref. En] [Central Food Technological Res. Inst., Mysore, India]

Effect of organic acids, mango peel, colloidal corrosion inhibitors and lacquering of cans on uptake of Sn by canned mango nectar (MN) was investigated, using MN of 15° Brix and 0.3% acidity. After storage of cans of MN for 1 yr at 25-28° C or 37° C, Sn contents were 200 and 510 ppm respectively. Corresponding values for other fruit juices were: pineapple, 180 and 320 ppm; orange, 153 and 295 ppm; and tomato, 148 and 270 ppm. Addition of 0.2% solutions of sodium alginate, carboxymethyl cellulose or gelatin reduced uptake of Sn, but agar-agar, glycine and citrus pectin were ineffective. Addition of mango peel had no effect on dissolution of Sn.
Packaging of MN in lacquered or partially lacquered cans reduced Sn uptake, but imparted a 'lacquer' off-flavour. In a model expt. (i) sugar syrup (SS); (ii) SS + 0.5% oxalic acid; (iii) SS + 0.5% tartaric acid; (iv) SS + 0.5% citric acid; and (v) SS + 0.5% malic acid were canned. Sn contents after 1 yr storage at 25-28° C and 37°C respectively, were: (i) 30 and 52 ppm; (ii) 280 and and 350 ppm; (iii) 148 and 208 ppm; (iv) 150 and 215 ppm; and (v) 133 and 200 ppm. It is concluded that the presence of citric and malic acids in MN are not responsible for the high uptake of Sn during storage. AJDW

[Induced malo-lactic fermentation in Piedmont wines.]
Malan, C. E.; Tarantola, C.; Gandini, A.; Ozino, O. L.; Curzel, V.; Castino, M.
Vini d'Italia 11 (58) 54-55 (1969) [It]

The bacterial conversion of malic to lactic acid necessary for the maturing of Piedmontese wines can be a slow process. Certain lactic bacteria isolated during malo-lactic fermentation have a marked capacity for accelerating the reaction. Inoculation results in almost complete degradation of the malic acid in 2 months, after an induction period of ~20 days. Better results are obtained if $CaCO_3$ is added to wine of high acidity or SO_2 content to raise the pH ~0.1 before adding the lactic bacteria. Complete conversion can be effected in 50 days. HSi

[Further data on the contents of glycerol, pyruvate, citrate and malate in different types of beer.] Weitere Ergebnisse über den Gehalt verschiedener Biersorten an Glycerin, Pyruvat, Citrat and Malat.
Mändl, B.; Wullinger, F.; Fischer, A.; Piendl, A.
Brauwissenschaft 23 (1) 11-18 (1970) [10 ref. De, en, fr] [Inst. für Technische Mikrobiologie und Technologie der Brauerei II, Weihenstephan, W. Germany]

In continuation of earlier investigations [see FSTA (1969) 1 11H1157], results of enzyme analysis of (i) 12 pale lagers, (ii) 10 pale export, (iii) 2 dark lager, (iv) 2 dark export, (v) 2 March, (vi) 13 Pilsner, (vii) 2 wheat and 1 Altbier, (viii) 2 pale strong and (ix) 2 dark strong beers from various German breweries are given. Average values (mg/l.) for (i)-(ix), respectively, were: glycerol 1683, 1655, 1491, 1409, 1545, 1586, 1736, 1914, 1915; pyruvate 53, 63, 61, 68, 68, 56, 42, 66, 53; citrate 183, 195, 185, 216, 204, 182, 183, 271, 276; malate 73, 92, 71, 71, 86, 86, 34, 75, 56. Other characteristics of the beers are tabulated, and the biochemical mechanisms involved in the formation of the fermentation by-products studied are discussed. IF

[Pattern of enzyme development during germination of barley.] Zur enzymatischen Kennzeichnung der Keimung der Gerste.
Mändl, B.; Wullinger, F.; Fischer, A.; Piendl, A.
Brauwissenschaft 23 (5) 175-85 (1970) [52 ref. De, en, fr] [Inst. für Technische Mikrobiologie und Technologie der Brauerei II, Weihenstephan, W. Germany]

Behaviour of 12 enzymes and of the 6 substrates glucose, fructose, pyruvate, citrate, malate and ethanol was studied during malting; analytical methods for determination of enzymic activities and for substrates are given in detail. Amylase, hexokinase, fructose-6-phosphatase, pyruvate-kinase, isocitrate and malate dehydrogenase, glucose-6-phopshatase and 6-phosphogluconate dehydrogensae showed a very similar behaviour. They decreased to a greater or lesser extent during steeping and rose during germination. Cellobiase increased slowly during steeping, then fell continuously. Invertase reached a max. on the 3rd day of germination and then declined. Acid phosphatase dropped very slightly during steeping, then rose continuously during germination; it did not reach its max. within the 9 day germination period used in the trials. Aldolase decreased during steeping and on the 1st day of germination, then rose slightly and finally decreased again. Glucose and fructose increased in concn. continuously from the 1st day of germination. Pyruvate attained its max. during steeping, then declined. Citrate reached a peak on the 6th day of germination. Malate declined during steeping, rose at the beginning of germination then fell gradually. Ethanol revealed its highest value during steeping but was consumed completely by the 3rd day of germination. TUB-IGB

[Contents of glycerine, pyruvate, citrate and malate in different types of beer.] Über den Gehalt verschiedener Biersorten an Glycerin, Pyruvat, Citrat and Malat.
Mändl, B.; Wullinger, F.; Fischer, A.; Piendl, A.
Brauwissenschaft 22 (7) 278-84 (1969) [18 ref. De, en, fr] [Inst. für Technische Mikrobiologie und Technologie der Brauerei II, Weihenstephan, W. Germany]

The following beers were examined by enzymic methods (provided by the firm of Boehringer, Mannheim, W. Germany) for the presence of various metabolic by-products of yeast: (i) 5 pale lager, (ii) 2 dark lager, (iii) 7 pale Export, (iv) 2 dark Export, (v) 5 Pilsner, (vi) 2 March, (vii) 2 wheat, (viii) 2 pale strong, and (ix) 2 dark strong. Average values (mg/l.) for glycerine, pyruvate, citrate and malate in (i) to (ix), respectively, were: glycerine 1647, 1443, 1823, 1495, 1622, 1629, 1870, 1852, 1832; pyruvate 59, 61, 66, 79, 59, 60, 53, 51, 56; citrate 185, 174, 203, 187, 194, 199, 151, 266, 279; malate 80, 54, 98, 54, 85, 74, 59, 136, 57. Other analytical results are given for each type of beer (e.g.

The content of glycerol and organic acids in different types of beer. [Über den Gehalt der verschiedenen Biersorten an Glycerin und organischen Säuren.
Mändl, B.; Piendl, A.
Proceedings, European Brewing Convention 13: 343-354 (1971, publ. 1972) [40 ref. De, en, fr]

[Continued from preceding abstr.] The average malate content of pale lager beers was 70 mg/l. March, Wheat, dark Export and dark strong beers generally contained less. Pilsener lager, dietetic Pilsener, pale Export, strong and especially "Alt" beer possessed considerably more. Relationships between original gravity, attenuation limit and other beer properties are discussed and metabolic pathways for formation of glycerol and organic acids in yeast are outlined. AS

[Experimental studies on the use of the bentonite 'Majorbenton B' in the fermentation of grape musts.]
Margheri, G.; Turra, P.
Vini d'Italia 14 (79) 327, 329, 331, 333-334 (1972) [28 ref. It] [Lab. di Analisi e di Ricerca, Istituto Agrario Provinciale, S. Michele all' Adige (Trento), Italy]

To study the effect of addition of the bentonite (i) Majorbenton B to grape musts during fermentation, 4 vats were set up containing: (a) untreated must, (b) must containing 50 g (i)/hl, (c) must containing 100 g (i)/hl and (d) must containing 100 g (i)/hl and 30 g activated carbon/hl. Analyses to study malolactic fermentation were carried out over a period of approx. 6 wk and a final total analysis was carried out approx. 4 months after fermentation began. Results showed that (i) reduced acidity and SO_2 content (the effect being greatest in (d)), gave wine with an increased amount of lactic acid and a decreased amount of malic acid, regulated the fermentation, inhibited the activity of polyphenoloxidase, gave wine with improved organoleptic qualities, and obviated protein turbidity. Wine treated with (i) matured quickly and could be sold at an early date. LA

The effect of potassium fertilization on the acid content of "Concord" grape juice.
Mattick, L. R.; Shaulis, N. J.; Moyer, J. C.
American Journal of Enology and Viticulture 23 (1) 26-30 (1972) [14 ref. En] [Dept. Biochem., St. Agric. Expt. Sta., Cornell Univ., Geneva, New York 14456, USA]

High acidity is detrimental to the flavour of "Concord" grape juice. The feasibility of reducing tartaric acid content to promote greater precipitation of potassium acid tartrate was studied with grapes of various K contents. The tartrate and malate contents of juices prepared from these grapes were determined before and after storage at 28°F. Reduction of tartrate content in storage was proportional to the K contents of leaf petioles and grapes, but the quantity of K that can be absorbed under growing conditions in New York is insufficient to effect the desired reduction in acid content. AS

[Influence of chemical composition of raw material on enzymatic preparations activity.]
Mikeladze, G. G.; Kutateladze, L. L.
Vinodelie i Vinogradarstvo SSSR 31 (4) 18-19 (1971) [Ru] [Gruzinskii Nauchno-issled. Inst. Pishchevoi Promyshlennosti MPP SSSR, USSR]

The influence of some cations, sugars, tannins and organic acids, contained in the raw materials used for production of fruit wines, on proteolytic activity of enzyme preparations added was studied. The fruits serving as raw material were plum, rose hip and Cornelian cherry. A stimulatory effect on proteolytic activity was observed with Ca and Mg ions, and with sucrose; an inhibitory effect was observed with K and Na ions, in the organic acids investigated (citric, malic and tartaric) and in tannins at concn. of 0.2%. Glucose and fructose had no effect. STI

[Assimilation of organic acids in wastes from potato starch manufacture by yeasts.]
Milanovich, O. M.; Poskrebko, T. A.; Stakheev, I. V.
Sakharnaya Promyshlennost' 45 (9) 64-66 (1971) [Ru] [Belorusskii Ordena Trudovogo Krasnogo Znameni Politekhnicheskii Inst., USSR]

Assimilation of citric and malic acids was studied during cultivation of Candida tropicalis in a medium consisting of 1:1 mixture of tuber water and potato crush hydrolysate. Given sufficient nutritive material, assimilation of 0.45 g of organic acids may yield 0.158 g of fodder yeast with 90% dry matter content. STI

Studies on organic acid metabolism and ethylene production during controlled atmosphere storage of apples (Malus pumila Miller, cv. Rolls).
Murata, T.; Minamide, T.
Plant and Cell Physiology (Tokyo) 11 (6) 857-63 (1970) [21 ref. En] [Fac. of Agric., Univ., Iwata, Shizuoka, Japan]

Organic acid metabolism and ethylene formation during controlled atm. storage (CA storage) of apples (Malus pumila Miller, cultivar Rolls) were studied. A higher tiratable acidity was observed in apples during CA storage as compared to those in air control. The incorporation of atmospheric $^{14}CO_2$ into malic acid was greater in apples stored in the higher CO_2 concn. The conversion of succinic acid-^{14}C into fumaric acid-^{14}C was slightly less in the apple in modified high CO_2 atm. than those in air. O_2 uptake and CO_2 output by apple slices were markedly inhibited by the addition of succinic and malic acids at a concn. higher than 25 mM. These factors seem to be the possible cause of a higher acidity of fruits stored in CA condition. Ethylene production from whole fruits or tissue slices was markedly inhibited under CA condition. The retardation of acid metabolism and the inhibition of ethylene production of apples during CA storage seem to be the important factors which help to maintain their storage quality. AS

[Studies of tannins of fruit and vegetables. V. colour olevelopment of tannin b the iron ion.]
Nakabayashi, T.
Journal of Food Science and Technology (Tokyo) 17 (6) 231-36 (1970) [Ja, en]
[Ja, en]

Effects of Fe salts, oxidation and reduction, temp., pH, and organic and inorganic acids on the colour development of various tannins and low molecular polyphenols by the Fe ion, were studied. Colour developed by the ferric ion was reduced by ascorbic acid. With an increase in pH, the optical density increased. Increase in colour intensity was observed at high temp. Polybasic acids, such as citric, tartaric, malic, and phosphoric acid which have a chelating action with Fe, prevented the formation of phenol-Fe complex and several foods containing these acids showed little discoloration with Fe. Chelating action of the polyphosphoric acids, phytic acid, and EDTA was affected by pH. [See preceding abstr.] HE

Effects of oxygen and carbon dioxide on respiration, storage life, and organic acids of green bananas.
McGlasson, W. B.; Wills, R. B. H.
Australian Journal of Biological Sciences 25 (1) 35-42 (1972) [15 ref. En] [Plant Physiol. Unit, Div. of Food Res., CSIRO, North Ryde, NSW 2113, Australia]

Green bananas were held in humidified gas streams comprising air (control); "high CO_2" (A) (5% CO_2, 20% O_2, 75% N_2); "low O_2" (B) (0% CO_2, 3% O_2, 97% N_2); "high CO_2-low O_2" (C) (5% CO_2, 3% O_2, 92% N_2). Ripening in A, B, and C was delayed at least 2, 8, and 12 times respectively compared with air. These 3 gas streams also reduced the rates of O_2 uptake by the fruit but increased the total O_2 uptake over the period before the beginning of the respiratory climacteric. In the first 4 days of treatment, A caused increases in pyruvate, oxaloacetate, 2-oxoglutarate, glyoxylate, glutamate, aspartate, citrate, and malate but not in succinate; B caused larger increases in the 2-oxo acids and decreases in the other acids; C caused smaller increases in pyruvate, 2-oxoglutarate, and glyoxylate, retarded the increase in oxaloacetate, and caused a further reduction in citrate, malate, and aspartate compared with B. The largest changes in the acids were found at 0-1 days. Application of the crossover theorem of Chance to the data suggested that low O_2 limited the operation of the Krebs cycle between pyruvate and citrate, and 2-oxoglutarate and succinate. No control points for high CO_2 were apparent. AS

N

[Amino acid composition of Georgian table wines.]
Nanitashvili, T. S.; Shilakadze, Ts. A.
Trudy, Gruzinskii Nauchno-Issledovatel'skii Institut Pishchevoi Promyshlennosti 5: 23-26 (1971) [6 ref. Ru] [Gruzinskii Nauchno-issled. Inst. Pishchevoi Promyshlennosti, USSR]

Data are presented on amino acid composition (paper chromatography) of wines from Rkatsiteli and Mtsvane grapes made by the European method, and of Rkatsiteli wine prepared by the Kachetian (Tbilisi) method. The lower content of S amino acids and aromatic amino acids in the last wine is ascribed to intensity of oxidative processes during pomace fermentation under constant stirring and aeration. Effects of fining, storage, and of heat and proteolytic enzyme treatment on amino acids of European-type wine from Rkatsitli grapes are briefly discussed. SKK

[Effects of grape pomace treatment with pectolytic enzyme preparations.]
Nanitashvili, T. S.; Sanadashvili, Ts. V.
Trudy, Gruzinskii Nauchno-Issledovatel'skii Institut Pishchevoi Promyshlennosti 5: 197-200 (1971) [Ru] [Gruzinskii Nauchno-issled. Inst. Pishchevoi Promyshlennosti, USSR]

Rkatsiteli, Mtsvane and Tsolikauri white grape pomaces were treated for 5 h at 25°C with 0.04% Avamorin P2K pectolytic enzyme preparation (3000 unit/g) and Saperavi and Cabernet red grape pomaces were treated with 0.05% of the preparation for 6 h at 30°C. Titratable acidity and chemically determined contents of sugar and tartaric, malic, citric, succinic and oxalic acids in the resultant and control musts, as well as in port-type and table wine made from enzyme-treated and control Rkatsiteli musts are tabulated. Results of chromatographic estimation of organic acids are graphically presented for Rkatsiteli and Saperavi musts and wines. It is concluded that pectolytic enzyme treatment increased contents of tartaric, citric and (to some extent) malic acids in must; and that it increased contents of tartaric and malic acids and

[New techniques of wine making.] [A lecture]
Negre, E.; Roubert, J.; Marteau, G.
Bulletin de l'Office International du Vin 44 (487) 827-848 (1971) [21 ref. Fr] [Ecole Nat. Superieure Agronomique de Montpellier, France]

The French report reviews topics discussed in the preceding abstr. Carbonic maceration is stated to favour production of good wines, resulting from a different anaerobic metabolism of the grapes. The method is mostly of interest in warm countries, and provides a more controlled fermentation which influences the rate of the malic acid degradation in the grapes and finally the acidity of the wine. Continuous wine making with maceration has developed greatly in the South of France; the quality of the wines proved about equal to those prepared in the traditional way. Heating of the vintage for red wine making shows good prospects; the quality of the wines is good, compared to that of traditionally prepared wines, provided the vintage is not heated >70°C. The economics of the method had still to be studied. A review is given on current studies in France on new techniques of wine making. JMS

[Method for preparing a dry gelatin product and method for using this for a gelatin pudding powder.]
NV Lijm- en Gelatinefabriek 'Delft'
Netherlands Patent Application 6 809 670 (1970) [Nl]

An edible acid (citric, tartaric, malic, succinic, adipic, fumaric) is dissolved in an aqueous gelatin solution, which is then dried to form a solid product soluble at room temp. The amount of acid used is preferably 5-20% of the wt. of the gelatin. The resultant solid powder is mixed with the required amount of sugar and optionally with flavouring and colouring substances. W&Co

[Deterioration of oils and fats of the hardened coconut oil series. VII. Preventing the deterioration by addition of surfactants.]
Niiya, I.; Kinoshita, Y.; Imamura, M.; Okada, M.; Matsumoto, T.
Journal of Japan Oil Chemists' Society [Yukagaku] 19 (7) 473-481 (1970) [22 ref. Ja, en]

3 kinds of surfactants were investigated for this purpose. Addition of 0.5-2% of monostearin, monopalmitin, or monolaurin increased acid value, but did not prevent deterioration. Addition of 0.5-1% of sorbitan monoacylate ester, polyoxyethylene sorbitan monoacylate ester, or lecithin showed no increase in acid value when stored at 15°C for 6 months. Sucrose acyl ester was less effective. Malate monoglyceride increased acid value. Observations on the crystal surface were made using an electron microscope. [See preceding abstr.] SKa

[Decomposition of L-malic acid in musts with Schizosaccharomyces pombe.]
Nonomura, H.; Shida T.; Ohara, Y.; Kagami, H.; Watanabe, M.; Kazama, K.
Journal of the Society of Brewing, Japan 63 (7) 765-70 (1968) [19 ref. Ja] [Faculty of Engineering, Univ., Yamanashi, Japan]

5 strains of S. pombe, which decomposes L-malic acid vigorously in grape juice, were selected from 84 strains of 50 yeast spp. 1 of the strains produced as much alcohol as Saccharomyces cerevisiae and tolerated higher concn. of SO_2 and sugar, but had a slower growth rate and a higher optimum temp. than those of wine yeast. Studies of the fermentation of grape and apple musts are included. HK

[Methods of analysis and components of wines. Account of the 11th meeting of the subcommittee of methods of analysis and evaluation of wines, Paris, 6-7th May, 1969.]
Office International de la Vigne et du Vin
Bulletin de l'Office International du Vin 42 (462/63) 922-54 (1969) [Fr]

Minutes of the meeting are presented under the following headings: methods of determining wine and must constituents (citric acid, malic acid, carbon dioxide, tartaric acid, phosphates, chlorides, total nitrogen, nitrates, calcium, manganese, sulphur dioxide, ascorbic acid, diglucosides, methanol); investigations of antiseptics in wines; investigations of substances possibly added to wines (caramel, synthetic colouring materials, artifical sweeteners, sodium); oenological Codex; methods of determining enzymes, vitamins and nitrogen-containing compounds in wine. JMS

[Malo-lactic fermentation. IV. Malic decomposition by Schizosaccharomyces pombe.]
Otsuka, K.; Hara, S.; Saito, H.
Journal of the Society of Brewing, Japan 63 (7) 771-75 (1968) [19 ref. Ja] [Res. Inst. of Brewing, Takinogawa, Kita-ku, Tokyo, Japan]

The decomposition of malic acid in grape juice and wine is studied. The activity of malic-decomposition by S. pombe was independant of the kind of pre-cultural medium. The effects of temp. and time of the reaction, and concn. of the yeast were evaluated. Optimum pH 2.8-4.0, alcohol content, <13% (vol.). Addition of SO_2 to the culture medium had no effect on the reaction, but that of alanine or aspartate promoted the reaction. An objectionable musty flavour of wines was decreased by treatment with S. pombe. [See J. Soc. Brew. Japan (1967) 58: 727, 1081; (1968) 63: 597.] HK

P

[Studies on the preservation of apples by plastics film coating.]
Park, N. P.
Journal of the Korean Agricultural Chemical Society 13 (2) 131-151 (1970) [100 ref. Ko, en] [Radiation Res. Inst. in Agric., Office of Atomic Energy, Seoul, Korea]

Apples were coated with a plastics film by dipping them in a plastic emulsion. Storage life of the apples was improved, resulting in a delay in after-ripening, shrivelling, softening and a reduction in the consumption of reserve materials. Effect of the deposited film on the fruit was due to increased CO_2 and decreased O_2 partial pressure in the apple tissue. Good results were obtained with PVA 117 for American summer Pearmain and Jonathan, and PVC 443 for McIntosh. Reduction in the diminution rates of L-malic acid, ascorbic acid and soluble pectin was observed in the plastics coated apples. KoSFoST

[Determination by electrometric titration of the organic acids of musts, crust and wine.]
Pato, M. A. da S.; Pato, M. H. M. L. S. da S.; Ferreira, M. E.
Vinea et Vina Portugalie Documenta, Series II: Enologia 6 (3) 15pp. (1972) [3 ref. Pt, fr] [Centro Nacional de Estudos Vitivinicolas, Lisbon, Portugal]

Equations are developed for the calculation of concn. of succinic acid and malic + tartaric acids from potentiometric readings obtained during titration over the pH range 3.3-6.0. The detailed procedures described involve preliminary separation from sulphates and phosphates of lactic acid (on the basis of the solubility of its Ba salt in neutral ethanol) and of malic, tartaric and succinic acids (on the basis of the solubility of their Ba salts

[Effect of malo-lactic fermentation on the true acidity of wines.]
Pato, M. A. da S.
Vinea et Vina Portugalie Documenta, Series II: Enologia 6 (4) 8pp. (1971) [4 ref. Pt, fr] [Centro Nacional de Estudos Vitivinicolas, Lisbon, Portugal]

Predicted changes in pH of wine due to decarboxylation of up to 60 mmole malic acid/l. by malo-lactic fermentation are presented graphically for wines of initial pH 3.0-3.5 and initial titratable acidities of 60-120 m-equiv./l. ECA

[Chemical composition of fruit juices and fruit wines.] Über die chemische Zusammensetzung von Obstsäften und Obstweinen.
Patschky, A.; Schöne, H.-J.
Flüssiges Obst 39 (4) 139-148 (1972) [9 ref. De] [St. Chem. Untersuchungsanstalt, Munich, Federal Republic of Germany]

Analytical data for fruit wines and sparkling wines and the parent fruit juices are presented in tables. Malic:citric acid ratios found in fruit juices were: apple 1:0.01; blackberry 1:0.05; bilberry 1:2; red current 1:3; black currant 1:20; cranberry 1:600; Morello cherry 1:0.02; gooseberry 1:2; wild raspberry 1:35. Other analytically important results for juices were high sorbitol content (22-83 g/l.) in Morello cherries, low K (600-880 mg/l.) in bilberries, and high catechol (6.2 g/l.) and low pH (2.4) in cranberries. About 10% of apple juices did not reach the min. required 45° Oechsle. The above acid ratios can be used for evaluation of fruit wines. Expected max. values for anions are 0.35 g/l. Cl^-, 0.5 g/l. SO_4^{2-} and 0.65 g/l. PO_4^{3-}. Sensory evaluation showed high contents of oxidized compounds and low SO_2 in apple and strawberry wines, and low sugar-free extract and acid in sparkling strawberry wine. RM

[Concentration of grape must by reverse osmosis.]
Peynaud, E.; Allard, J.-J.
Comptes Rendus Hebdomadaires des Seances de l'Academie d'Agriculture de France 56 (18) 1454-1458 (1970) [Fr]

High pressure pumps coupled to electric motors transported filtered grape must at room temp. and under pressure over a series of cellulose acetate semi-permeable membranes held in tubular plastics supports. Using this reverse osmosis equipment the following results were obtained in a wine-making plant: 5320 l. of must passed over 30 m^2 of membrane in 3 h 10 min and 975 l. of H_2O were eliminated. Retained in the must were 99.8% of the original sugars; 10% malic acid and some K were lost with the water. A major advantage of this system of concn. is that the organoleptic properties of the must are unaffected, as the process is carried out at room temp. SAH

Energetics and control of malo-lactic fermentation.
Pilone, G. J.
Dissertation Abstracts International. Section B. The Sciences and Engineering 32 (9) 5003-5004: Order no. 72-9907 (1972) [En] [Univ. of California, Davis, USA]

Changes in the major organic acids of ripening grapes.
Plessis, C. S. du
South African Journal of Agricultural Science 11 (2) 237-47 (1968) [24 ref. En, af, fr] [Viticultural and Oenological Res. Inst., Stellenbosch, R. of S. Africa]

4 white grape cultivars, viz. White French, Stein, Riesling, and St. Emilion were sampled at harvesting and periodically during the 2 months just prior to harvesting in 1962 and 1964. The total acidities, pH, degrees Balling, total malates and total tartrates were determined. It was found that for a specific time the total acidities of the 1962 samples always exceeded those of their 1964 counterparts. This tendency was not noted for total malates, for although all 1962 samples were initially higher than those of 1964, the position was reversed in Stein and Riesling at harvesting. The examination of total tartrates and total malates as a function of total acidity indicated that the latter group was more effective in its influence upon the decrease of total acidity than the former. A significant negative correlation was determined between total malates and degrees Balling for each cultivar and each yr. No statistically significant correlations could be determined between noted fluctuations of tartrates and/or malates and h of sunshine rainfall and max. and min. temp. AS

The effect of growth regulators on changes in fruits of 'Thompson Seedless' grapes during cold storage.
Pool, R. M.; Weaver, R. J.; Kliewer, W. M.
Journal. American Society for Horticultural Science 97 (1) 67-70 (1972) [6 ref. En] [Univ. of, California, Davis, USA]

'Thompson Seedless' fruits from vines that had received gibberellin or auxin treatment were separated into different maturity classes and stored at 0° for 98 days. Samples were withdrawn at about monthly intervals and soluble solids, total acidity, malic acid, arginine and proline were measured. Fruits with differing soluble solids concn. had the same soluble solids content/berry. After 30 days of storage, the soluble solids concn. and total acidity of non-gibberellin treated fruits began to increase, probably as a result of water loss. Malic acid concn. and content increased for 30 days in storage, remained stable for the next 28 days, and then decreased during the remainder of the storage period. The amino acids, arginine and proline, remained relatively constant during the first 58 days of storage and then increased greatly both in concn. and content. AS

Effect of temperature on threshold values for citric acid, malic acid and quinine sulphate - energy of activation and extreme-value determination.
Powers, J. J.; Howell, A. J.; Lillard, D. A.; Vacinek, S. J.
Journal of the Science of Food and Agriculture 22 (10) 543-547 (1971) [31 ref. En] [Dept. of Food Sci., Univ., Athens, Georgia 30601, USA]

Thresholds for perception of citric and malic acid in surrounding temp. of 2, 20.5 and 41°C and of quinine sulphate at 3, 22 and 38°C were determined at the 50% level, the 75% ASTM level and at the 5% probability level. Although there were threshold differences dependent on temp., these were often overriden by judge-specific factors. Thresholds for the acids tended to be higher at 2°C than at the other temp. and were significantly higher for quinine sulphate at 3°C than at 22°C. The acid results support the view that pH is not responsible for sourness. Energy of activation for taste response was usually 5-20 kcal, suggesting that a process such as adsorption may be involved. Extreme value tests with quinine sulphate using many additional judges indicated that such methods should be useful in predicting the % of individuals whose thresholds will be below a certain level. MD

R

[Incidence of acid degradation by bacteria in German white wines.] Über die Häufigkeit des bakteriellen Säureabbaus in deutschen Weissweinen.
Radler, F.
Wein-Wissenschaft 25 (10) 418-24 (1970) [15 ref. De] [Inst. für Mikrobiol. und Weinforschung, Johannes Gutenberg-Univ., Mainz, W. Germany]

Incidence of bacterial acid degradation in 1034 samples of white wine was investigated by TLC. The wines were divided on the basis of their malic and lactic acid contents into 3 groups: complete, partial and no degradation of acid. The organoleptic quality of white wines in which the acids were completely broken down was inferior to wines in which the acid had not been degraded. MDB

[Problems of bacterial acid decomposition.] Problematik des bakteriellen Säureabbaus.
Radler, F.
Weinberg und Keller 19 (7) 357-370 (1972) [10 ref. De, en] [Inst. für Mikrobiol. & Weinforschung, Johannes Gutenberg Univ., Mainz, Federal Republic of Germany]

Problems of malo-lactic fermentation in wine-making and effects on wine quality are discussed. During evaluation of wines at the German federal wine competition, malo-lactic fermentation was shown to have no effect on red wines but an unfavourable effect on quality of white wines. Acetoin content was increased from 4.3 to 9.3 mg/l. (mean value), and diacetyl from 0.7-15.8 to 0.9-34.9 mg/l. RM

[Pudding compositions.]
Raion Hamigaki Co. Ltd.
Japanese Patent 12 258/70 (1970) [Ja]

Egg-based pudding compositions are coagulated by addition of salts of poly-basic acids such as calcium citrate, potassium malate or sodium tartrate. IFT

Internal corrosion of tinplate in canned ivy gourd (Kundree) (Coccinia indica Wright and Arn.).
Ranganna, S.; Rastogi, C. K.; Govindarajan, V. S.
Indian Food Packer 24 (2) 5-13 (1970) [28 ref. En] [Central Food Tech. Res. Inst., Mysore 2A, India]

Ivy gourd canned in plain, acid resistant (AR) and sulphur resistant (SR) lacquered cans made from either hot dip (HD) or electrolytic (E) tinplate caused complete detinning in 14 wk except in lacquered cans. SR lacquered cans cannot be used below pH 5.5 because of leaching of Zn. Pieces of tinplate cans were used to study the corrosive properties of the alcohol-soluble fraction, organic acids and phenolic from ivy gourd. It is concluded that the anionic constituents of ivy gourd, such as citric, malic and succinic acids, and phenolic compounds are responsible for detinning. Results are discussed. PEG

Malic acid - the food acid of the seventies'.
Reid, T. H.
Confectionery Production 38 (10) 542-543, 553 (1972) [En] [Croda Food Ingredients Ltd., Moss Bank, Widnes, Lancs., UK]

The properties of malic acid are first considered and its application to the manufacture of soft drinks, sugar confectionery (gelatin pastilles, table jellies), jams and preserves, canned products, biscuits, and to the prevention of rancidity of edible oils is outlined. VJG

[The effect of L-malate on the oxidation of citrate and of D-isocitrate in the mitochondria of potato tubers.]
Ribereau-Gayon, G.; Laties, G. G.
Comptes Rendus Hebdomadaires des Seances de l'Academie des Sciences, Serie D Science Naturelles 268 (18) 2290-93 (1969) [11 ref. Fr]

Intact potato mitochondria did not oxidize citrate and D-isocitrate except when L-malate was present. Evidence is presented to show that L-malate acts by making the mitochondrial membranes permeable to citrate and isocitrate. In the presence of L-malate, the cooperative activation of NAD:isocitrate dehydrogenase by D-isocitrate was demonstrated. MEG

Epidemiology and control of grape bitter rot caused by Melanconium fuligineum.
Ridings, W. H., II.
Dissertation Abstracts International. Section B. The Sciences and Engineering 30 (11) 4867 (1970) [En] [St. Univ., Raleigh, N. Carolina USA]

Expt. on M. fuligineum (which causes bitter rot in the muscadine grape, Vitis rotundifolia Michx.) were conducted, with screening of fungicides in vitro for the control of M. fuligineum. Mycelial growth and spore germination occurred at from 8°C to 36°C and with pH as low as 2.3; spores germinated poorly in water without addition of casein hydrolysate. Mycelial growth occurred in the berry organic acid (DL-malic and D-tartaric) at concn. as high as 2.4%. A sexual stage of reproduction was not found. Results of pathogenicity studies are indicated. The epidemiology of bitter rot was examined in berries of bunch and muscadine varieties at the University Farm, at Method, and the Central Crops Research Station, Clayton, both in N. Carolina. Most fungicides were more effective in preventing spore germination than in suppressing mycelial growth. GLS

[Malic acid as a factor influencing winemaking and storage of wines of warm regions, and appropriate methods of treatment.] [A lecture]
Rosenthal, P. S.; Loinger, C.
Bulletin de l'Office International du Vin 42 (466) 1313-18 (1969) [7 ref. Fr]

Influence of malic acid and malo-lactic fermentation was studied using red and white wines of 1964-1968 vintage; the wines were analysed and tested by a specialist tasting panel. The acidity was not changed in the must or in the wine. The authors conclude from their expt. that: malic acid is 1 of the factors of vintage differentiation, wines with consistently high taste ratings contain a high level of malic acid, independent of region or year; the total quantity of malic acid in a wine is not the decisive factor in the quality of a vintage, but the equilibrium between alcohol, total acidity, pH and malic acid; the best vintage wines have the highest acidity and proportionally the highest contents of malic acid; and wines in which malo-lactic fermentation does not occur are superior to wines in which it does. 13 methods of preventing malo-lactic fermentation are outlined. JMS

The silylation of substances occurring in natural products and detectable by gas chromatography.
Rumpf, G.
Journal of Chromatography 43 (2) 247-50 (1969) [4 ref. En] [Inst. of Radiation Technology, Federal Res. Centre for Food Preservation, 75 Karlsruhe, W. Germany]

Potato tubers were homogenized in methanol-water and the extract evaporated to dryness, in the reaction vessel. The silylation reagent (hexamethyldisilazane or trimethylchlorosilane in pyridine) was added and the vessel closed and stirred at room temp. until the residue had changed into a uniform precipitate of fine powder. This solution was injected directly into the gas chromatography apparatus. Malic and citric acids, fructose, α- & β-glucose, myo-inositol and sucrose were detected on the chromatogram. Silylated citric acid and fructose were incompletely separated. Quantitative silylation of increasing quantities of glucose, sucrose, malic acid and myo-inositol added to potato extracts was demonstrated. The advantages of the method are that no heat treatment is necessary and the extracts need not be purified. MEG

[Gas chromatographic determination of soluble constituents in potatoes treated by irradiation and with chemical sprout inhibitors.]
Gaschromatographische Bestimmung löslicher Inhaltsstoffe in bestrahlten und mit chemischen Keimhemmungsmitteln behandelten Kartoffeln.
Rumpf, G.
Potato Research 15 (3) 236-245 (1972) [16 ref. De, en, fr] [Inst. für Strahlentech., Bundesforschungsanstalt für Lebensmittelfrischhaltung, 75 Karlsruhe, Federal Republic of Germany]

Effects of irradiation, sprout inhibitor treatment and storage, on sucrose, glucose, fructose, citric acid, malic acid and myo-inositol content of Bintje, Maritta and Sieglinde potatoes were investigated. Batches of potatoes were (i) irradiated with 12 krad, (ii) treated with 20 ppm of a 1:1 mixture of isopropyl-N-phenyl carbamate (IPC) and isopropyl-N-(3-chlorphenyl)-carbamate (CIPC) or (iii) not treated (control samples) and stored for ≤11 months at 10°C and 85-90% RH. At intervals, 100 g samples were homogenized with 100 ml methanol and 50 ml pyridine, a solution of 400 mg trehalose in 100 ml water being added as an internal standard. After stirring in an Erlenmeyer flask for 1-2 h, a 25 ml sample was taken for citric acid determination; citric acid was precipitated from the remaining solution as barium citrate. After stirring for a further 1-2 h, a 25 ml sample was centrifuged, and 2 ml aliquots were dried, silylated and analysed by GLC. Tables and graphs of results are given. Citric acid concn. decreased, and malic acid and myo-inositol concn. increased gradually during storage, (i) and (ii) having little effect. Sugar contents of all samples remained relatively constant during the first 4 months of storage; after this, control samples had markedly higher sucrose and lower reducing sugar contents than (i) or (ii) samples. AJDW

[Use of ammonia during sherry-type wine production.]
Saenko, N. F.; Shur, I. M.; Kiselevskaya, R. M.
Vinodelie i Vinogradarstvo SSSR 31 (8) 11-14 (1971) [Ru] [Moskovskii Filial VNIIViV "Magarach", USSR]

Insufficient growth of the yeast pellicle during production of sherry-type wine is often associated with a lack of nitrogenous substances. The effect of addition of 25% aqueous solution of NH_3, in amounts of 150-200 mg/l. on sherry production was tested. Experiments showed the feasibility of using NH_3 addition even when the N content was sufficient (total N 867 mg/L, amino N 203 mg/l., NH_3 N 169 mg/l.); optimum amounts were about 150 mg/l. The added NH_3 influenced the synthesis of some amino acids, reduced the content of tartaric and malic acids; the citric, lactic and succinic acids content increased. STI

[Method for production of edible acids.]
Saidakhmetov, U. A.; Kadyrov, A. K.; Usmanov, Kh. U.; Rizaev, N. U.; Vulikh, A. I.
USSR Patent 345 196 (1972) [Ru]

Leaves of the cotton plant are extracted, and the extract containing calcium citrate and malate is separated, passed through a layer of carboxyl cation-exchange resin, e.g. KB-4P-2 in the Ca form, evaporated and crystallized, the pure acids being subsequently obtained by known methods. Before purification with resin, the extract is preferably cleaned by passing through strongly acidic cation-exchange resin in the H form and anion-exchange resin in the OH form. W&Co

[Determination of acidity in fruit syrups by conductometry using triethanolamine - titration of weaker acids.] Bestimmung der Acidität von Fruchtsyrupen auf konduktometrischem Wege mittels Triäthanolamins - Titration schwacher Säuren.
Sarudi, I., Jr.
Deutsche Lebensmittel-Rundschau 68 (4) 115-117 (1972) [11 ref. De, en, fr] [Nahrungsmittel-Kontrollinst. und Chem. Untersuchungsanstalt für den Landesbezirk Fejer-Veszprem, Szekesfehervar, Hungary]

Conductometric determination of acids in fruit syrups is described, using slightly basic triethanolamine solution to facilitate evaluation of titration curves. Pure formic, lactic, tartaric, acetic, malic, citric, oxalic, and succinic acids were estimated singly; total acids in raspberry, blackcurrant, strawberry, St. Lucie and cornel cherry, sloe, and mixed berry syrups were also determined. The method showed excellent reproducibility with an average SD of ±0.28%. OA

[Investigations with ^{14}C-labelled pyrocarbonic acid diethyl ester. III. Hydrolysis and alcoholysis.] Untersuchungen mit ^{14}C-markiertem Pyrokohlensäuredi-äthylester. III. Zur Hydrolyse und Alkoholyse.
Schelenz, R.; Fischer, E.
Zeitschrift für Lebensmitteluntersuchung und - Forschung 145 (5) 279-88 (1971) [11 ref. De, en] [Inst. für Strahlentech. Bundesforschungsanstalt für Lebensmittelfrischaltung, Karlsruhe, W. Germany]

The kinetics of the pyrocarbonic acid diethyl ester (PCE) hydrolysis in water, 5% and 10% solutions of ethyl alcohol and 5% solution of DL-malic acid were investigated with PCE (carbonyl-^{14}C). Hydrolysis is an first order reaction, the velocity being a function of the medium of hydrolysis, increasing with rising temp. at constant pH. Hydrolysis is terminated at room temp. and 42° C after 9 and 1.5 h respectively.

[Investigations with ^{14}C-labelled pyrocarbonic acid diethyl ester. IV. Reactions with DL-malic acid. Untersuchungen mit ^{14}C-markiertem Pyrokohlensäurediäthylester. IV. Reaktionen mit DL-Apfelsäure.
Schelenz, R.; Fischer, E.
Zeitschrift für Lebensmitteluntersuchung und - Forschung 147 (3) 145-153 (1971) [20 ref. De, en] [Inst. für Strahlentech. Bundesforschungsanstalt für Lebensmittelfrischhaltung, Karlsruhe, W. Germany]

The reaction in aqueous solution of DL-malic acid with ethyl-1- ^{14}C labelled and carbonyl-^{14}C labelled diethyl pyrocarbonate was studied chromatographically. All 7 theoretically possible ethylated and carbethoxylated malic acid derivatives were identified. At pH 3.6, 1-ethyl malate accounted for 73% of the reaction products. At pH 1.6 the total reaction products were increased ~10-fold and the relative quantities greatly altered. [See FSTA (1971) 3 9A421 for part III.] DSW

Chemical changes and pH stability in acidified canned tomatoes.
Schoenemann, D. R.
Dissertation Abstracts International, B 33 (1) 260: Order no. 72-20 414 (1972) [En] [Virginia Polytech. Inst. & St. Univ., Blacksburg, USA]

10 tomato varieties were canned, and the effects of additives on pH and composition evaluated. pH was depressed by approx. 0.2 units by salts of both citric and malic acids, added at <1.0 m-equiv./100 g tomato; fumaric and phosphoric acids were more effective. Drained wt., refractive index, can vacuum, can corrosion and chemical composition were not significantly affected by any of the acids used as acidulants. $CaCl_2$ and $MgCl_2$ depressed the pH by 0.06 units for each m-equiv. added up to 2 m-equiv./100 g tomato; these salts were approx. 7 times more efficient than NaCl for depressing pH. $CaCl_2$ was more effective than $MgCl_2$, NaCl or KCl in preventing drained wt. loss when ≤2 m-equiv. of each were added per 100 g tomato. Effects of processing times of 15 and 45 min at 210°F on tomato compositional changes were compared. 5 toamto varieties showed no significant pH change related to length of heat process; titratable acidity was slightly higher, by 0.1 m-equiv./100 g in tomatoes processed 45 min. Differences between the 2 processes were small, but correlations between variables were higher in the sample set processed for 45 min which indicates that thermal, non enzymatic effects were more pronounced in the 15 min set. AA

[Natural acids of fruit in sweetened, non-alcoholic beverages.] Die Fruchtsäuren in süssen alkoholfreien Erfrischungsgetränken.
Schumann, G.
Tageszeitung für Brauerei 69 (22/23) 122-123 (1972) [5 ref. De] [Versuchs- und Lehranstalt für Brauerei, Berlin, Germany]

The concn. of acids found in fruit (malic, citric, tartaric) are listed for 23 different fruits. For the manufacture of non-alcoholic beverages, the main acid used is citric, primarily on technological and economic grounds. The production and commercial forms of the major acids used for food purposes are described. TUB-IGB

[Malic acid content of grapes and malo-lactic fermentation in major Roumanian vineyards.] In "Microbiologia. Vol. I."

Septilici, G.; Alexiu, A.
pp. 671-676 (1970) [11 ref. Ro, fr] Bucharest, Roumania: Societatea de Stiinte Biologica [Inst. de Cercetari pentru Viticultura si Vinificatie, Valea Calugareasca, Roumania]

The malic acid contents of 4-6 varieties of grapes from the Iasi, Dragasani, Minis and Blaj vineyards at different stages of ripening are graphically presented, and the extent of malo-lactic fermentation of a must under standard conditions by 16 spp. of yeast is tabulated. Schizosaccharomyces spp. fermented malic acid almost completely; Saccharomyces chevalieri and Debaryomyces hansenii fermented ~25% of the acid; Sacch. cerevisiae and Sacch. ellipsoideus were less active, but good results were obtained by first using Schizosaccharomyces pombe and, 2-4 days latter, Sacch. ellipsoideus. Factors enhancing malic acid fermentation were: min. addition of SO_2, high pH, large yeast inoculum, high turbidity and prolonged contact of must with marc. SKK

Effects of controlled atmosphere (CA) storage on amino acids, organic acids, sugars, and rate of respiration of 'Lambert' sweet cherry fruit.

Singh, B.; Littlefield, N. A.; Salunkhe, D. K.
Journal. American Society for Horticultural Science 95 (4) 458-461 (1970) [19 ref. En] [Utah St. Univ., Logan, USA]

Sweet cherries (cv. 'Lambert') were kept in a CA consisting of 10.5% CO_2 and 2.5% O_2 at 1°C. The sample fruits were taken periodically during the treatment and also after termination of the CA treatment. The concn. of tyrosine, α-amino butyric acid, malic acid and total sugars were determined on an ethanolic extract of the fruit pulp. The respiratory CO_2 was measured for separate lots of 1.2-1.5 kg of fruit. Fruit stored at higher CO_2 concn. had a lower amount of tyrosine, and higher amounts of α-amino butyric and malic acids than fruits stored in the conventional refrigerator at 1°C. The respiratory rate was inhibited, and there was no significant effect on total sugar content. AS

[Effect of Candida mycoderma on some volatile and non-volatile constituents of wine.]

Spettoli, P.
Industrie Agrarie 9 (11) 381-387 (1971) [17 ref. It, en] [Istituto di Chimica e Ind. Agrarie, Univ., Padua, Italy]

The action of C. mycoderma (C. valida), added experimentally to 17 red and white wines, on some volatile and non-volatile constituents, was studied. Ethyl alcohol decreased considerably by 8.4-43.47%, both with and without formation of limited quantities of acetic acid. Contents of glycerin and 2,3-butylene glycol remained constant; tannin decreased by 4.7-26.3%; total acidity by 13.6-48.05%; extract by 5.32-26.90%; and esters by 31.03-73.84%. Acetaldehyde and acetoin increased by 266.6-1100% and 59.12-434.04% respectively; diacetyl disappeared; and higher alcohols decreased in some cases, increased in others, and remained constant in yet others. Succinic, lactic and malic acids were partially or completely oxidized; citric acid content was reduced by 6.58-77.6%; tartaric acid was not affected. The yeast had little effect on the colouring of the wines. AS

Inheritance of malate in tomatoes.

Stevens, M. A.; Long, M. A.
Journal. American Society for Horticultural Science 96 (1) 120-122 (1971) [11 ref. En] [Campbell Inst. for Agric. Res., Riverton, New Jersey, USA]

Flavour evaluation studies with 'Campbell 146' and 'Campbell 1327' indicated that 2-isobutylthiazole concn. and solids/acid ratio are important to the flavour difference between these 2 cultivars. 55 tomato lines from divergent sources were analysed to study relationships among components contributing to quality variation. There were highly significant correlations among major components contributing to solids. As TS increased, the proportion of reducing sugars, the predominant organic compounds, increased. Despite a highly significant negative correlation between pH and titratable acidity, there was a wide range in the [H+]/titratable acidity ratio. The data indicate that differential buffering is primarily responsible for this variation and that phosphate content of the fruit is a prime factor in differential buffering. Citrate, but not malate, concn. was correlated with titratable acidity. [See also FSTA (1972) 4 6J836 & 5J754.] AS

[Application of Schizosaccharomyces in the biological breakdown of acids.] Ausnutzung von Schizosaccharomyces beim biologischen Säurenabbau.

Svejcar, V.
Wein-Wissenschaft 25 (1) 1-5 (1970) [10 ref. De] [Lehrstuhl für Weinbau, Hochschule für Landwirtschaft, Brno, Czechoslovakia]

Schizosaccharomyces pombe is able to decompose L-malic acid in must and wines in the presence of SO_2. The activity of Schizo. pombe in decomposing malic acid in wine was compared with that of $CaCO_3$ and with a control sample. The acid content was measured by titration with 0.3N KOH, using a 15% 5-day pure culture. There were decreases in acid content of 38.3, 32 and 26% in the wine with 15% Schizo. pombe, with $CaCO_3$ and in the control, respectively. Organoleptic values, using the 20-point system, were 18.30, 17.48 and 16.78 respectively. MDB

[Malate dehydrogenase in the ripening tomato.]

Swardt, G. H. de; Duvenage, A. J.
Agroplantae 3 (4) 69-72 (1971) [20 ref. Af, en, fr] [Randse Afrikaanse Univ., Braamfontein, Johannesburg, South Africa]

[Semi-quantitative determination of tartaric, citric, malic, lactic and succinic acids in alcoholic and non-alcoholic beverages by T.L.C.]

Dünnschichtchromatographischer Nachweis bzw. halbquantitative Bestimmung der Wein-, Citronen-, Äpfel-, Milch- und (Bernstein-)säure in süssen und vergorenen Getränken.
Tanner, H.; Sandoz, M.
Schweizerische Zeitschrift für Obst- und Weinbau 108 (8) 182-186 (1972) [6 ref. De] [Eidgenössische Forschungsanstalt, Wädenswil, Switzerland]

Details are given of method, equipment and techniques used in TLC for identification and determination of tartaric, citric, malic, lactic and succinic acids in non-alcoholic and alcoholic beverages. This method, which has been used successfully to determine organic acids in unfermented fruit and vegetable juices can differentiate various R_f values, using 3 different colour dyes. Compared with paper chromatography, this method is time-saving and simpler to use, and results can be obtained within 1½ h after colour development, using Acridin in alcoholic solution (50%); moreover, only 1 µl is required for testing, and acids can be determined in micro-quantities. Decomposition of sweet and fermented wines can be determined by this method

[Baked goods preservative.]
Taiyo Kagaku Kogyo Co. Ltd.
Japanese Patent 9770 (1970) [Ja]
Malic acid monoglycerides are employed as preservatives in baked goods. IFT

[Meat substitute.]
Taiyo Kagakukogyo Co. Ltd.
Japanese Patent 22 790/72 (1972) [Ja]
Artificial meat products are prepared by emulsifying fat with malic acid monoglyceride in a vegetable protein base optionally containing animal, poultry or fish meat. IFT

[Study of objective criteria of the gustatory quality of Golden Delicious apples.]
Thiault, J.
Bulletin Technique d'Information 1970 (248) 191-201 (1970) [10 ref. Fr]
Samples of Golden Delicious apples from 1967-68 (500) and 1968-69 (approx. 500) harvests and from various origins were stored in different atm. and compared for the quality criteria, colour, odour, texture and taste. Significant relationships were observed between: colour and total sugar content; refractometric index and total sugar content; taste and total sugar content; taste and the sum of total sugar and acid content. Proportion of sucrose in total sugar content of apples was found to change after harvest: 25% in Oct.; 22% in Jan.; 14.5% in Feb.; 13.5% in March and 8% in May. From this it was concluded that the relationship sucrose/total sugar is not a feasible test for quality. The importance of the different criteria in determining the quality of Golden Delicious apples is discussed. It is stated that the refractometric index can give a satisfactory indication of the gustatory quality, but that the sum of total sugars and acids gives a better indication in the formula TS + 10A (TS = total sugars in g/l. juice; A = acidity in g/l. juice, malic acid). TS + 10A >160 agrees with favourable quality and >170 with superior quality. It is stressed that for analysis at least 50 fruits from each lot should be sampled. These results are presented as representative for France only. JMS

[Chromatographic determination of organic acids of Kuban' beet.]
Troyanova, N. L.; Botova, N. N.
Izvestiya Vysshikh Uchebnykh Zavedenii, Pishchevaya Tekhnologiya No. 4, 30-32 (1970) [6 ref. Ru] [Krasnodarskii Politekh. Inst., USSR]
In view of the technical problems involved with the processing of beet from the Kuban' region of the USSR, a paper chromatographic analysis of its acid contents was made, using a beet extract and cellular and diffusion juices as test objects. No difference was observed between the extract and the juices, and the acids found were glycolic, malic, citric and acids with R_f of 0.28 and 0.16. HBr

Effect of potassium nutrition on various aspects of tomato metabolism, with special reference to fruit pigmentation.
Trudel, M. J.
Dissertation Abstracts International. Section B. The Sciences and Engineering 30 (12) 5318-19: Order no. 70-5783 (1970) [En] [Cornell Univ., Ithaca, New York, USA]
Incorporating C^{14}-mevalonic acid in fruit carotenoids was achieved with intact fruit, high K-status fruit incorporating more of the label in the carotenoids, indicating that carotenoid synthesis is reduced by K-deficiency. It was suggested that K regulated the amount of neurosporene aiding formation of either lycopene or β-carotene. Chlorophylls decreased as total carotenoids increased during ripening. K-deficiency effects on leaf pigmentation, net photosynthesis and respiration were determined at regular intervals, and detrimental effects on photosynthesis were evident 3 wk after induction. Respiration increased with low K status, and total N and soluble proteins were increased. Detrimental effects of K-deficiency were evident at all stages of ripening, and organic studies showed that pyruvic acid accumulates in red-fruit under severe K-deficiency. Attention is also given to content of citric acid, malate, fumarate, and oxalo-acetate. GLS

The fate of some organic acids added to grape juice prior to fermentation.
Wagener, W. W. D.; Ough, C. S.; Amerine, M. A.
American Journal of Enology and Viticulture 22 (3) 167-171 (1971) [16 ref. En] [Drakenstein Winery, PO Box 19, Simondium, South Africa]
The technique of GLC of the trimethylsilyl acid derivatives was used to show the effect of the addition of tartaric, citric, L-malic, succinic and fumaric acids at 0.1 and 0.3 g/100 ml to musts prior to fermentation. The wines underwent normal fermentations with no significant delays due to changes in acidity. All the measured acids showed decreases during fermentation except succinic and malic in some instances. Biochemical method of removal of each acid is discussed. Succinic acid measurements during the earlier part of fermentations were unreliable because of inability to dissolve the acid. All samples showed a uniform gain in succinic acid during fermentation. Addition of tartaric acid caused precipitation of potassium bitartrate. Fumaric acid was metabolized rapidly, probably through malic acid. Citric acid showed a steady uniform decrease during fermentation of 0.05-0.10 g/100 ml. Malic acid decreased at the higher concn. during fermentation. Wines after 6 months storage showed that tartaric acid had an important effect on wine pH, and that fumaric acid had an inhibiting effect on malolactic fermentation in wine from Malbec grapes. PG

[...] of temperature on development of premature ripening in 'Bartlett' pears.
Wang, C. Y.; Mellenthin, W. M.; Hansen, E.
Journal. American Society for Horticultural Science 96 (1) 122-126 (1971) [22 ref. En] [St. Univ., Corvallis, Oregon, USA]

Premature ripening, a physiological disorder of 'Bartlett' pears, was induced experimentally by use of temp. controlled limb cages. Exposure to 65°F day and 45°F night temp. for 3-31 days prior to harvest caused an early acceleration in ethylene production and occurrence of the climacteric rise in respiration. These changes were accompanied by fruit softening, increases in soluble pectin and protein N, a more rapid decline in malic acid as well as a decrease in the rate of citric acid accumulation. Treatments with gibberellic acid (GA_3), 100 ppm, and succinic acid 2,2-dimethyl hydrazine (Alar), 3000 ppm, counteracted the effect of cool temp. exposure and retarded premature ripening. The disorder did not develop in fruit maintained at 75°F day and 60°F night temp. during the experiment. AS

[Malolactic fermentation in wine. IV. Determination of the presence of bacteria during or after alcoholic fermentation.] Der biologische Säureabbau im Wein. IV. Untersuchungen zum Auftreten der Bakterien während bzw. nach der alkoholischen Gärung.
Weinar, R.; Wartenberg, H.
Mitteilungen: Rebe, Wein, Obstbau und Früchteverwertung 21 (1) 32-42 (1971) [40 ref. De, en, fr, es] [Friedrich Schiller Univ., Jena, E. Germany]

The effect of alcohol, acidity and temp. on bacteria and malolactic fermentation in wine was investigated with Fröhlig-Silvaner must. Bacterial growth (Bacterium mannitopoeum and Micrococcus acidovorax) was dependent on sugar and alcohol concn., content of tartaric acid and pH; at 110°C Oechsle and pH <3.2 inhibition of bacterial growth was evident. At relatively low sugar and alcohol contents and pH 2.8, strong bacterial growth occurred. Spontaneous growth of bacteria paralleled the degree degradation of malic acid; in wines with high malic acid concn. no bacteria can develop. Partial degradation of malic acid may be attributable to delayed bacterial growth. It is concluded that the date of degradation of malic acid is essentially dependent on the final content of alcohol and pH. [See also FSTA (1971) 3 3H317.] JMS

[Investigation of the importance of tartaric acid for hydrogen ion concentration in wine. VI. The cH^+ of grape must. VII. Model experiments.] Untersuchungen zur Bedeutung der Weinsäure für die Wasserstoffionen-Konzentration des Traubenweines. VI. Die cH^+ von Traubenmosten. VII. Modell-Versuche.
Weinar, R.
Mitteilungen: Rebe, Wein, Obstbau und Früchteverwertung 21 (6) 441-452 (1971) [5 ref. De, en, fr, es] [Sektion Biologie-Pflanzenphysiologie, Friedrich-Schiller-Univ., Jena, German Democratic Republic]

Changes in cH^+ (hydrogen ion concn.) of 6 types of wine were studied, with reference to tartaric acid, malic acid, K, and ash alkalinity. In grape juice the cH^+ value depended largely on tartaric acid and K content. The cH^+ of the grape juice virtually determined the cH^+ of the wine. The amount of salt in grape juice or wines was not influenced by highly concn. of malic acid. It was demonstrated in model experiments that the cH^+ is to a great extent depended on K concn. and salt concn. Identical changes in cH^+ can occur by equimolecular variations of both the K and the tartaric acid. [See FSTA (1970) 2 3H364 for part V.] OA

[Investigation of the importance of tartaric acid for hydrogen ion concentration in wine. VIII. Theoretical considerations with special reference to malic acid degradation and tartrate precipitation.] Untersuchungen zur Bedeutung der Weinsäure für die Wasserstoffionenkonzentration des Traubenweines. VIII. Theoretische Erörterungen unter besonderer Berücksichtigung des Äpfelsäureabbaues und der Weinsteinausfällung.
Wejnar, R.
Mitteilungen: Rebe, Wein, Obstbau und Früchteverwertung 22 (1) 19-37 (1972) [53 ref. De, en, fr, es]

Theoretical studies based on extensive calculations confirmed the experimental results of parts VI and VII [see preceding abstr.], viz. that: grape must or wines are not constituted as pure acid solutions; according to the Henderson-Hasselbach equation cH^+ is not entirely dependent on the amount of acid, but on the equilibrium between acid and salt, concn. of the latter being regulated by the solubility product of tartrate; degradation of weakly dissociated malic acid does not cause fundamental changes in cH^+, provided that strongly dissociated tartaric acid remains in solution; and as a result of malic acid degradation, part of K, or alkalinity of ash, is fixed by tartaric acid, instead of malic acid. This effect can be compensated or over-compensated by precipitation of tartrate. OA

[Biological acid degradation in wine. VI. Control of the degradation of malic acid by pure bacterial cultures.] Der biologische Säureabbau im Wein. VI. Lenkung des Äpfelsäureabbaus mit Bakterien-Reinkulturen.
Wejnar, R.
Zentralblatt für Bakteriologie, Parasitenkunde, Infektionskrankheiten und Hygiene. II. Abteilung 126 (6) 575-579 (1971) [17 ref. De, en] [Sektion Biol. Pflanzenphysiol., Friedrich-Schiller-Univ., Jena, E. Germany]

Malic acid was broken down in heat-sterilized grape must by the action of a mixture of added bacteria (Bacterium gracile, Bacterium mannitopoeum, and Micrococcus acidovorax); this required ~1 month. Addition of tartaric acid retarded this action. [See also FSTA (1972) 4 5H762 & 4H603.] AFa

Non-volatile organic acid and sugar composition of Saskatoon berries (Alnifolia sp.) during ripening.
Wolfe, F. H.; Wood, F. W.
Canadian Institute of Food Technology Journal 4 (1) 29-30 (1971) [5 ref. En, fr] [Dept. of Food Sci., Univ. Alberta, Edmonton, Alberta, Canada]

Malic, oxalic and citric acids are the only non-volatile organic acids present in ripening Saskatoon berries (Alnifolia sp.) in measurable concn. Levels of these acids, as well as the levels of glucose, fructose and sucrose are reported for 3 varieties of Saskatoons presently being cultivated at the Canada Department of Agriculture Research Station at Beaverlodge, Alberta. Results indicate that the organic acids content of Saskatoons is comparable to that of apples, and that the fructose levels in the berries may decrease fairly rapidly after ripening. AS

[Acids - a factor determining quality of wine.]
Die Säuren - ein qualitätsbestimmenden Faktor im Wein.
Wucherpfennig, K.
Deutsche Wein-Zeitung 105 (30) 836-40 (1969) [17 ref. De] [Inst. für Weinchemie und Getränkeforschung, Hessische Lehr- und Forschungsanstalt, Geisenheim, W. Germany]

Factors influencing acid taste in wine were investigated. Acid taste was not related to pH or titratable acidity, but was significantly reduced by alcohol, slightly by sugar, and was unaffected by glycerol. 5 wines were compared with tartaric acid solutions of equal titratable acidities. The tartaric acid solutions had a more acid taste. It was shown that acid taste is related to buffering, the presence of other constituents, and the acid involved. Considerable differences in acid taste were found in solutions of 17 organic acids containing 20 nM of undissociated acid/l. The acid tastes of tartaric, malic, and citric acids were similar, while that of lactic acid was less intense. A different order of acidity was obtained with 0.05N solutions: the acid taste of malic and tartaric acids was the same, that of lactic and citric acids was milder. pH, total acidity in g/l., conductivity, dissociation constant, % adsorption on Al_2O_3 or polyvinylpyrrolidone were not correlated with the taste of acid solutions. The acid taste of wine was unaffected by varying the proportions of malic and tartaric acids. RM

Z

Potato extractives: sloughing as related to replacement of anions or cations.
Zaehringer, M. V.; Cunningham, H. H.
American Potato Journal 48 (10) 385-389 (1971) [13 ref. En] [Dept. of Home Economics Res., Agric. Expt. Sta., Univ., Moscow, Idaho 83843, USA]

All anions or cations were removed from potato extract and were replaced by a single, naturally occurring anion or cation in an effort to determine the relative effect of each on the sloughing of potato tissue. The treated extracts were used in cooking soaked potato tissue slices. In the anion series, citrate caused the greatest amount of sloughing. Other cooking media and treatments in decreasing order of effectiveness were untreated extracts, malate, oxalate, chloride and distilled water. In the cation series, Na and K caused significantly more sloughing than the untreated extract. Mg and Ca firmed the potato tissue, resulting in less sloughing than that obtained with distilled water. AS

[Chemical and physico-chemical characteristics of deposits in wine musts.]
Zykina, T. F.
Izvestiya Vysshikh Uchebnykh Zavedenii, Pishchevaya Tekhnologiya 1968 (5) 44-48 (1968) [10 ref. Ru] [Odesskii Tekhnol. Inst. Pishchevoi i Kholodil'noi Promyshlennosti, USSR]

The deposits in freshly pressed wine must are heterogeneous complexes, containing components of cellular juice soluble in water, substances of protein character, polyphenols, ash and fragments of cellular walls. The physico-chemical properties and the chemical composition of the deposits depend on the degree of pressing and the type of equipment. It is possible to assess indirectly the effectiveness and quality of the pressing equipment for producing natural wine must from the chemical composition of the sediments. STI

II. MALIC ACID 1920-1969

ITEMS NOT INCLUDED IN REVIEW PB-223 865

Biological Abstracts

13266. AMERINE, MAYNARD A. (U. California, Davis.) The acids of California grapes and wines. II. Malic acid. Food Technol 5(1): 13-16. 1951.--Malic acid is found on California grapes up to 55% of the sum of malates plus tartrates as grapes begin to ripen. During ripening malic acid decreases (1) on per berry basis, (2) on juice basis, and (3) as percent of sum of tartrates and malates. At maturity the malic acid constitutes from about 12-45% of the sum of the tartrates and malates. The difference between vars. begins to develop early in the season. In California, vars. with a relatively low malate content are preferable. No regular difference between seasons or climatic regions was observed.--M. A. Amerine.

2175 AMERINE, M. A., and A. J. WINKLER. (U. California, Davis.) [illegible] with California grapes. III. The acid content of [illegible], and stems. Proc. Amer. Soc. Hort. Sci. 41: 199-206. [illegible] fruit the tartrate and malates decrease during the ripening, either on a per ml of juice or a per 100 berry basis. For [illegible] fruits the decrease calculated by the 2 methods is [illegible] but for a very large berried variety, which increases [illegible] in size during ripening, the decrease on a per berry basis is [illegible], especially for tartrates. The tartrate and malate contents of [illegible] and stems vary irregularly during the growing [illegible]. The tartrate content of the leaves and stems is relatively [illegible] than malate compared to the fruit. The juice of the fruit [illegible] a buffer coefficient indicating a high buffer capacity. The buffer [illegible] decreases during maturation. Titration curves for grape [illegible] are smooth and cannot be used for calculating the organic acid [illegible].--H. A. Amerine.

B

3335. BENEDICT, C. R. (Dartmouth Med. Sch., Hanover, N. H.), and HARRY BEEVERS. Formation of sucrose from malate in germinating castor beans. II. Reaction sequence from phosphoenol-pyruvate to sucrose. Plant Physiol. 37(2): 176-178. 1962.--Evidence is presented that the following enzymes are present in the endosperm tissue of germinating castor beans: 3-phosphoglyceric mutase, enolase, phosphoglyceryl kinase, DPN- and TPN-linked triose phosphate dehydrogenases, aldolase, and uridine diphosphoglucose-glucose transglucosylase. These enzymes, acting in the presence of ATP and reduced nucleotide generated during fatty acid oxidation are believed to be responsible for the formation of sucrose from phosphoenol-pyruvate which is itself produced from oxaloacetate by phosphoenolpyruvate carboxykinase.--Authors.

3613. BENEDICT, C. R., and H. BEEVERS. (Purdue U., Lafayette, Ind.) Formation of sucrose from malate in germinating castor beans. Conversion of malate to phosphoenol pyruvate. Plant Physiol. 39(5): [illegible] 1964.--[illegible] phosphoglyceryl kinase and phosphoglyceraldehyde dehydrogenase [illegible] in the presence of ATP and reduced [illegible] DPN or TPN provide the conditions necessary to convert phosphoenol pyruvate to malate. [illegible] required as a cofactor in this reaction. [illegible] labeled phosphoenol pyruvate was produced from [illegible] labeled glucose, and [illegible] labeled phosphoenol pyruvate was produced when [illegible] was converted, via [illegible] to [illegible] from [illegible]. The results presented support the [illegible] that phosphoenol pyruvate carboxykinase is one of the enzymes involved in the conversion of malate to sucrose in [illegible] germinating castor beans.--Author

RESPIRATION

20683. BENNET-CLARK, T. A. The rôle of the organic acids in plant metabolism. *New Phytologist* 32 (1): 37-71. 3 fig. 1933.—Three groups of plants are distinguished: (1) malic acid-containing plants in which malic acid is formed from carbohydrate in darkness and converted into it in light. This group is said to include all succulent plants except certain of the Centrospermae and many non-succulent plants such as the Orchidaceae and Bromeliaceae, (2) Malic acid plants in which the young parts contain chiefly malic acid, but in which oxalic acid appears and malic acid disappears as the plants become older. *Rheum*, *Mesembryanthemum* and others rich in oxalic acid are probably of this type. The fact that *Rheum* and possibly other plants in this group are rich in ammonium emphasizes the interrelationship of the malic acid metabolism with the protein metabolism; malic acid produced from carbohydrate might be its reaction with ammonium causes a shift: Protein (or amino acid) + Carbon residue + CO_2. (3) Oxalic acid-containing plants such as *Begonia* and *Oxalis*. These might be regarded as a special case of the 2nd group in which the change malic acid→oxalic acid proceeds much more rapidly than in such types as *Rheum*. Investigation of the acid metabolism of fruits has so far failed to throw light on the process. Special peculiarities of the nutrition of mould fungi make a comparison of their acid metabolism with other plants in general terms impossible.—*G. E. Avery, Jr.*

[illegible] BULLER, W. J. [illegible]

19074. BENNET-CLARK, T. A. The respiratory quotients of succulent plants. *Sci. Proc. Roy. Dublin Soc.* 20 (paper 21): 293-299. 2 fig. 1933.—When excised leaves of *Sedum praealtum* are darkened, the rates of CO_2 output and O intake undergo a series of characteristic changes. The rate of CO_2 output falls to a minimum value attained about the 6th hr. after darkening, and then rises to a value which remains nearly constant for many days. At the same time the rate of O intake at first rises to a maximum and then falls to a minimum value, finally rising so that the R. Q. eventually attains the value of unity. Thus the R. Q. is considerably lower than unity during the phase of starvation in which carbohydrate is being converted into malic acid. It greatly exceeds unity in the subsequent phase, during which the acid formed during the 1st phase disappears. Maximum values for the R. Q. of 1.39 and 2.95 are recorded here, and somewhat similar values have been recorded previously. Other exps. yielding similar results have been made which are not recorded here. These high values are inconsistent with the view that malic acid disappearance is due to its oxidation and provide additional evidence in favor of the view advocated before that malic acid forms a link in a C cycle in succulent plants similar in some respects to the C cycle of apple deduced by Blackman. The sequence of changes postulated is of the type

carbohydrate ← polysaccharide,
↓
(intermediates) → malic acid.
↓
CO_2 —*Author's summary.*

[illegible] Alkoholverbrauch bei der

[illegible] PENIGAR, S. [illegible], and DONALD R. CARR. (Allied Chem. Corp., Morristown, N. J., U.S.A.) Malic acid in place of citric acid in hard candy. FOOD TECHNOL. 20(11): 97-98. 1966.- Cherry, raspberry and lemon-flavored candies prepared from vacuum-processed 60:40 sucrose-42-DE corn syrup mixture and containing various amounts of DOMALURE food-grade malic acid (Allied Chemical Corporation) were compared with controls containing citric acid by a sensory panel. Equivalent acid taste was attained at the 87-90% replacement level

[illegible]RKA, A., and [illegible]. [illegible] (Inst. Appl. Chem., [illegible]ne, Czech.) Bestimmung organischer Stoffe durch Oxydation [illegible]manat: IV. Die Oxydation von Milch-, Apfel-, Zitronensaure. [Determination of organic substances using the permanganate: IV. Oxidation of lactic, malic, citric [and salicyl]ic acid.] [illegible] ACTA (1/2): 171-185. Illus. [illegible] and [illegible]. sum.]--A study has been made of the influence [illegible] in the oxidation of malic, citric, lactic and salicylic acid with permanganate. From the analytical standpoint a milieu of [s]ulfuric acid is best suited for a rapid and quantitative oxidation [of malic] and citric acid to carbon dioxide and water, a milieu of [illegible] [acet]ic acid is most suitable in the case of salicylic acid. Lactic [acid is] best determined by a previously described procedure in a medium of 5% H_2SO_4 at an elevated temperature.--Authors.

40105. BRECHOT, P., J. CHAUVET, H. CROSON, and R. [illegible] (Inst. Pasteur, Paris, France.) Disparition de l'acide malique pendant la vinification de vendanges entieres en Beaujolais (année 1965): Role du raisin, des levures et des bacteries. [Disappearance of malic acid during wine production in entire harvests in Beaujolais (year 1965); Role of grapes, yeasts and bacteria.] ACAD AGR FRANCE COMPT REND HEBD SEANCES 52(6): 592-597. 1966.--Measurement of malic acid at progressive stages of alcoholic fermentation showed that yeasts have a relatively unimportant role in the metabolism of this acid. About 1/5 of the malic acid is degraded by enzymes of grapes and 65-75% by bacterial enzymes.--B. J. Cohen.

17059. BERNHAUER, K., H. BÖCKL, und H. SIEBENÄUGER. Über die Säurebildung aus Zucker durch Aspergillus niger. V. Die Bildung von Äpfelsäure neben Citronensäure. *Biochem. Zeitschr.* 253(1/3): 37-41. 1932. --Systematic analysis of culture liquors, containing sucrose as the C source, from 23 strains of *A. niger* revealed the formation of malic acid in addition to citric acid but the presence of succinic, fumaric and tartaric acids could not be demonstrated. Malic acid was isolated by ether extraction of the culture solutions and subsequent conversion to Hg fumarate and was produced at the rate of 3 gms. for each 500 gms. of citric acid. Its formation occurred under conditions that were optimal for the production of citric acid.—*O. E. May.*

513. BUCK, R. E., and H. H. MOTTERN. l-Malic acid as by-product in apple sirup manufactured by ion exchange. Indust. and Engineer. Chem. 39: 1087-1090. 1947.

3001. BHATTACHARJEE, JNANENDRA K. (Albert Einstein Med. [Coll.], Philadelphia, Pa., USA.), MICHAEL E. MARAGOUDAKIS, and [M]URRAY STRASSMAN. Identification of malic acid from yeast [Sac]charomyces]. J BACTERIOL 95(2): 495-497. 1968.--Evidence [indic]ated an accumulation of L-malic acid in the synthetic growth [medi]um of both lysine auxotrophs and wild-type yeast. Malic acid was [isol]ated from growth experiments and was identified by paper and [gas] chromatography (by comparison of infrared spectra with authentic L-malic acid), as well as enzymatically, as a substrate of malic [dehyd]rogenase. Malic acid was accumulated when glucose was used as [carb]on source. This did not occur when sodium lactate was the carbon [sour]ce. Malic, succinic, and citric acids, and a few others as yet un[ident]ified organic acids, were accumulated in the culture supernatant [wh]en yeast was grown in chemically defined medium. The [accu]mulation of these acids had no obvious relation to the pathway for [lysi]ne biosynthesis.--Authors.

511. Buck, R. E., and H. H. Mottern. Apple sirup by [ion] exchange process. *Indust. and Engineer. Chem., Indust.* [37](7): 635-639. 6 fig. 1945.—The removal of most of [th]e malic acid from apple juice by anion adsorption avoided [th]e bitter aftertaste of calcium malate formed by liming the [ori]ginal juice in the prepn. of apple sirup. Anion adsorption [al]so removed arsenic from spray residue. Lead was almost [com]pletely removed in the final step of liming and was not [a se]rious problem. Three methods of treatment were tested [fr]om the standpoint of flavor the simplest treatment with [a we]ak anion exchanger was the most practical. It removed [abou]t 80-90% of the acid and produced a palatable sirup [wi]th little flavor other than that of sweetness. A variable [qua]ntity of arsenic was removed by the single treatment. [To in]sure more complete removal when it becomes necessary, [a 2]-step (cation-anion) or a 3-step (anion-cation-anion) ex[chan]ger treatment must be used. As much as 96% of the [arsen]ic content was removed by the 3-step method, and a [sma]ller amt. was eliminated by the 2-step method. In addi[tio]n, the cation exchanger removed about 90% of the ash.—[Be]ltsy Exp. Sta. Rec.

77631. LOE, A. A., J. Y. DO, and D. K. SALUNKHE. (Plant Sci. Dep., Utah State Univ., Logan, Utah, USA.) Some biochemical changes occurring during the development and ripening of tomato fruit (Lycopersicon esculentum Mill.). INDIAN J HORT 24(3/4): 160-165. Illus. 1967[recd. 1969].--Acidity was lowest in the immature stage and highest at the stage when coloration was initiated with a rapid decrease as the fruit ripened. The soluble solids and reducing sugars increased throughout development of the fruit. Citric acid concentration followed a curve similar to total acidity. Malic acid occurred in small amounts and decreased as the fruit ripened. Both beta carotene and lycopene increased as the fruit developed from mature green into the ripening stages.--H. Chakraverty.

5835. BUHLER, D. R., ELMER HANSEN, B. E. CHRISTENSEN, and C. H. WANG. (Oregon State Coll., Corvallis.) The conversion of $C^{14}O_2$ and CH_3-$C^{14}O$-COOH to citric and malic acids in the tomato fruits. Plant Physiol. 31(3): 192-195. 1956.--Mature green tomatoes were treated with $C^{14}O_2$ and pyruvate-2-C14 in separate experiments. Major portion of the incorporated activity was detected in the fruit acids and amino acids fractions. Degradation studies on malic and citric acids isolated from the fruit used in these experiments indicated that: (1) CO_2 fixation is operative in this fruit; (2) CO_2 fixation appeared not to be the major pathway for malic acid biosynthesis in the dark; and (3) small amount of CO_2 is incorporated directly into the tertiary carboxyl-C atom of citric acid probably by way of isocitrate formation from alpha-ketoglutarate and CO_2. --C. H. Wang.

5645. BOHRINGER, P., and T. [illegible] (Landes-Lehr u. Forschungsanstalt Wein u. Gartenbau, Neustadt/Weinstrasse, Germany.) [illegible] [illegible] Weinsteinsäure: Die [illegible] [illegible], der Vereinigung [illegible] [illegible] [illegible] Wein u. Keller 2(1/2): 31-[illegible]. Illus. 1955.

C

CARR, J. G. (Pics. Sta., Long Ashton, Bristol, Eng.) Lactic ...ria as residue organisms of fruit juice products. Jour. ... 21(2): 267-271. 1958.--The spoilage of wines and ciders ... acid bacteria is described. The pioneering work on wine ...terology at the turn of the century is discussed in addition to modern ...rried out in Australia and the U.S.A. Similarly, past and ...work on the spoilage of ciders by lactic acid bacteria is dis- ...special reference being made to their activity against malic ... as well as chlorogenic acid and its derivatives.--Auth. summ.

3012. CHALLENGER, FREDERICK, and LOUIS ...The formation of l-malic acid from fumaric acid by Aspergillus niger. *Jour. Chem. Soc.* [*London*] 1929 (Aug.): 1644-1647. 1929.

...GAULARD, C. E. Molecular complexity ...

317. Charley, V. L. S., D. P. Hopkins, and A. Pollard. (*Hort. Res. Sta., Long Ashton, Bristol, Eng.*) Malic acid as a by-product in the production of apple treacle. *Fruit Prod. Jour.* 22(4): 108-110. 1942.—When apple juice is evaporated for production of treacle, an appreciable quantity of malic acid can be recovered by precipitation as the crude Ca salt; the conditions of precipitation and of recovery of the pure acid from crude Ca malate are described.--*L. A. Hohl.*

7148

CHARLEY, V.L.S., D.P. Hopkins & A. Pollard

7149-7159 HORTIC

...lic acid as a by-product in the production of apple ...acle. *Ann. Rept. Long Ashton Agric. Hort. Res. Sta.* ...11: 96-101. 1942.—1) A method is described whereby malic acid can be isolated from the crude Ca salts obtained in the evaporation of neutralized apple juices. 2) The conditions required to obtain precipitation of the salts are given.—*Authors' summ.* (*courtesy Hort. Absts.*).

7228. CHAUVET, J., P. BRECHOT, P. DUPUY, MADELEINE ...Chauvet, and R. HOELLARD. (Chvage Chauvet Freres et Cie, La Chapelle de Guinchay, France.) Evolution des acides malique et lactique dans la vinification par maceration carbonique de la vendange. [Evolution of malic and lactic acids during vinification of the vintage by carbonic maceration.] ANN. TECHNOL. AGRIC. 12(4): 231-246. illus. 1964. [English summ.]--Vinification by carbonic maceration without grapes crushing caused a more rapid and more clearly defined disappearance of malic-acid in a vintage beaujolais than vinification by the traditional regional process. The intracellular degradation of malic-acid was studied by putting grapes into a plastic bag which was placed in the tanks where the carbonic maceration took place; the disappearance of malic-acid proceeded to about 25% without the appearance of lactic-acid. At the end of carbonic maceration, lactic-acid was an important constituent of the fermented juice present in the bottom of the tanks; and there were also numerous bacteria visible under the microscope. With traditional methods of vinification, at the time the vine was removed from the mare, only a little part of malic-acid was fermented to lactic-acid by bacteria.--F. Lurandiqe.

...BOULARD, J., and P. VINET. Evolution des acides malique ...

...with reference to the process of air curing; a small ... disappears ... result ... A fraction of malic acid ... The phenomena most ... Fall and increase, remains ... and appeared ... completion of curing ... acid, become strongly in- ... at the time of harvesture.

--Authors.

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20913. DAWE, C. Jr., C. O. CHICHESTER, and G. L. MARSH. (U. California, Davis.) Studies of processed all-green asparagus. III. Qualitative and quantitative studies of non-volatile organic acids by chromatographic techniques. Food Res. 24(1): 20-27. 1959.--Organic acids positively identified in processed all-green asparagus are fumaric, succinic, alpha-ketoglutaric, pyrrolidonecarboxylic, glycolic, malic and citric. The presence of other acids was indicated.

Cont

Pyrrolidonecarboxylic acid was not found in fresh asparagus, and evidence indicated that it may be produced during heat processing from glutamine. Citric acid is the only acid showing a substantial increase in the tip section as the stalk increases in length above ground. A change in the ratio of citric to malic follows. Results indicate that the major buffering system in asparagus is not the organic acids but probably a combination of acid anions, amino acids and proteins.

--G. L. Marsh.

19277. DILLEY, D. R. (Mich. State Univ., E. Lansing, Mich., USA.) The influence of controlled atmosphere storage on respiration and malic acid decarboxylation of apple fruit. In: Proceedings of the plant physiology meetings, 1962. Plant Physiol. 37(Suppl.): 61. 1962.--Abstract.

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...STOCK ...ate of ...ace- ...: 159- ...formed ...tic ...-gallic ...f pro- ...ing

23393. DITTRICH, H. H. (Staatlichen Weinbau-Inst., Freiburg im ...Brsg., W. Germany.) Zum Chemismus des Apfelsaureabbaues mit ...der Hefe der Gattung Schizosaccharomyces. [The chemical mechanism of the decomposition of malic acid by a yeast of the strain Schizosaccharomyces.] Wein-Wiss. 18(6): 406-410. 1963. [German with English summ.]--The decrease of the sugar-free extract during fermentation by a Schizosaccharomyces strain proceeds at the same rate as the reduction of the malic-acid content. The malic-acid is oxidized to CO_2 and H_2O. In an anaerobic medium the malic-acid is mainly decomposed to ethanol. Under more favorable fermentation conditions the malic-acid percentage from which alcohol is formed will increase.--Author.

24594. DRAWERT, F., A. RAPP, and W. ULRICH. (Forsch.-Inst. Rebenzuchtung Geilweilerhof, Siebeldingen/Pfalz, Ger.) Bildung von Apfelsäure, Weinsäure und Bernsteinsäure durch verschiedene Hefen. [The production of malic, tartaric, and succinic acids by various yeasts.] NATURWISSENSCHAFTEN 52(11): 306. 1965.--Cultivation of various yeasts in nutrient media consisting of water, glucose, inorganic and organic N compounds (amino compounds), and a concentrated Wickerham basal medium, resulted in measurable formation of malic, tartaric and succinic acid.--J. Grauman.

29253. DRAWERT, F., A. RAPP, and W. ULRICH. (Forschungsinst. Rebenzuchtung, Landau/Pfalz, West Ger.) Über die Bildung von organischen Säuren durch Weinhefen. I. Quantitative Beziehungen zwischen Stickstoffquelle, Hefestamm und L-Äpfelsäurebildung in Hefezellversuchen. [The formation of organic acids by wine yeasts. I. Quantitative connections between nitrogen source, yeast strains, and L-malic acid formation in yeast fermentation studies.] VITIS (Ger.) BEIHEFT/GERCH 5(1): 20-23. 1965.

15413. DRYDEN, F. C., and CLAUDE R. HILLS. (Eastern Reg. Res. Lab., Philadelphia.) Consumer preference studies on apple sauce: sugar-acid relations. Food Technol. 11(11): 589-591. 1957.--A consumer panel ranked samples of apple sauce in which the sugar content and acidity were varied. Greatest preference was shown for a sauce of 22° Brix, with an acid content of about 0.45% (as malic acid).

--Authors.

...29115. DU PLESSIS, L. DEW. (Wilmot Cape Vocational Res. Sta., ...Stellenbosch, S. Afr.) ... of ... Acids and ... VII. ... from ... [Formation and ... from ... and ... Extraction ... Cape ... and ... with ... for ... acid ... acid ... Lactic ... all ... [Abstract ...

EGGEBERGER, W. Biochemische Untersuchungen über Reifen während der Entwicklung und Lagerung. [Biochemical investigations of apples during development and storage.] Ber. Schweiz. Bot. Ges. 59:91-130. 1949.--During ripening the weight of Gloster, Schoner Schoner increased 5.1 times and of Waldhöller 3.8 times, while during storage the wt. continually decreased. During ripening the decrease of the water content was 2-7 times the loss of dry substance. The content of mineral substances per apple increased during ripening and then remained constant. When calculated per fresh wt, a decrease was observed followed by a small increase after maturation. The P content remained relatively constant. The free acids per apple increased till shortly before harvesting but decreased during the subsequent storage. When calculated per fresh wt. they decreased from the beginning. The content of citric acid was very small and was less metabolized than malic acid. The sugar content increased during ripening (per apple and per fresh wt.), the sucrose increasing more rapidly than the other sugars. The N content per fresh wt. strongly decreased till the middle of September, although the N content per apple increased during this period but again decreased shortly before maturation. The lipoid content is small but increased during ripening. The synthesis of starch began during June, had a max. in August after which hydrolysis preponderated. During harvest a small starch content was still present. The contents of cellulose and total pectic substances (as calculated from the uronic acids) increased during ripening and remained constant during storage. The degree of methylation of the pectic substances increased until maturation by 45-60% as well as the ether methoxyl. In consequence it is improbable that lignin is formed from pectin. The percentage of soluble pectin varied between 45-90% and increased during ripening; its degree of methylation was rather constant (75%). The remaining residue after extraction was slightly methylated. In the beginning the extracted pectin was contaminated with polysaccharides. The viscosity of extracted pectin was high in the beginning, already decreased before maturation and further decreases during storage. The jelly-forming properties were originally small, then increase and further change were proportional to the viscosity. Chemical analysis cannot characterize the ripening condition.--A. Quispel.

† 13697. EL-MANSY, HUSSEIN I., and DAVID R. WALKER. (Plant Sci., Utah State Univ., Logan, Utah, USA.) Seasonal fluctuations of amino acids, organic acids, and simple sugars in 'Elberta' peach and 'Chinese' apricot flower buds during and after rest. J. Amer. Hort. Sci. 91(2): 187-192. Illus. 1967.--Fifteen amino acids, 3 organic acids, and 3 sugars were identified and measured quantitatively in peach and apricot flower buds during and after the rest period of 'Elberta' peach and 'Chinese' apricot buds. Total amino acids increased just prior to the completion of rest in peach buds. Proline and alanine were the predominant amino acids in peach buds. Glutamic acid and proline were predominant during rest. Aspartic acid, serine, and phenylalanine increased considerably after rest was completed. Total organic acids increased slightly in peach buds after rest, while malic and citric acids showed considerable increases. In apricot buds, total organic acids increased 5-fold during the rest period was completed in mid-winter. Much of the increase which occurred, mainly in the last sampling before rest was completed, was due to fumaric, citric, pyruvic, succinic, and malic acids. After completion of rest, the sugars increased from 5- to 9-fold in peach and more than 2-fold in apricot buds.

† 13812. KE[illegible] Growth [illegible] rest. 196[illegible] ions of re[illegible] tically co[illegible] through [illegible] ments, th[illegible] ic and a [illegible] generall[illegible] ic malic[illegible] growth [illegible] ility mec[illegible] during [illegible] This te[illegible] to the [illegible]

13813. KI[illegible] ge dannye

† 13820. FLESCH, PETER. (Pharm. Inst., Johannes Gutenberg-Univ., Mainz, West Ger.) Malic-Enzym-Synthese und pH-Adaptation bei L-Apfelsäure abbauenden Bakterien. [Malic enzyme synthesis and pH-adaptation of bacteria, decomposing L-malic acid.] ARCH MIKROBIOL 64(1): 9-22. Illus. 1968. [Engl. summ.]--The malic enzyme synthesis of 6 strains of bacteria, decomposing L-malic acid, is investigated. Under the tested conditions, the homofermentative strains form exclusively an adaptive malic enzyme, while the synthesis of the heterofermentative strains may occur adaptively or constitutively, dependent on the growth conditions. The otherwise positive glucose effect on activity and induction cannot be observed for the constitutive malic enzyme. The pH-optima of the malic acid decomposing activity of the intact bacteria are shifted to lower situated pH values if the cells are adapted to higher H^+-ion concentrations in artificial and natural environs. An origin of amino acid decarboxylase activities cannot be observed. Growing bacteria in a pH-adaptation have a larger demand for amino acids than normal, especially for alanine, glycocoll, glutamic acid, gamma-aminobutyric acid, valine and leucine. Adapted cells possess qualitatively and quantitatively less free amino acids than non-adapted. At last, a variation of the cell protein is established. Leuconostoc "r" bacteria, the protein of which contains especially glutamic and aspartic acids, dispose (after pH-adaptation) of larger quantities of lysine, asparagine and leucine, and La Louvière bacteria of more lysine and glutamic acid.

† 13820. FLESCH, PETER. (Pharm. Inst., Johannes Gutenberg-Univ., Mainz, West Ger.) Morphologie, Stoffwechselphysiologie und Charakterisierung der Malic-Enzym-Aktivität L-Apfelsäure-abbauender Bakterien. [Morphology, physiology and characterization of malic enzyme activity of bacteria, decomposing L-malic acid.] ARCH MIKROBIOL. 60(1): 285-302. Illus. 1968. [Engl. summ.]--Six strains of bacteria which ferment L-malic acid to lactic acid and CO_2, were investigated. Their morphology, properties of assimilation and their enzyme activities were determined. The shape and size of the cells and the demand of nutriments of the strains differ. Some strains decompose citric, fumaric and tartaric acids besides malic acid. Malic acid is an intermediate of the dissimilation of citric and tartaric acids by L. plantarum. All strains need glucose and fructose as C source. Its turnover is accelerated by the presence of malic acid. The typical bacteria, dissimilating malic acid, can be adapted to the conditions of the natural acid substances by increasing the (H^+) ion concentration step by step. All the strains investigated possess malic enzyme and oxalacetate decarboxylase activity. Homofermentative strains have

13874. FLESCH, PETER, and BRIGITTE HOLBACH. (Pharm. Inst., Johannes Gutenberg-Univ., Mainz, West Ger.) Zum Abbau der L-Apfelsäure durch säurebildende Bakterien: IV. Mitteilung. Die Aktivität intakter Lactobacillus plantarum-Zellen unter besonderer Berücksichtigung der Brenztraubensäure-Decarboxylierung. [The dissimilation of L-malic acid by lactic acid bacteria: IV. The activity of intact cells of Lactobacillus plantarum particularly considering the decarboxylation of pyruvic acid.] ARCH MIKROBIOL. 58(1): 63-70. Illus. 1967. [Engl. summ.]--The decomposition of L-malic, oxalacetic and pyruvic acids by intact cells of 3 strains of L. plantarum was investigated. The dissimilation of L-malic acid shows 2 pH-optima, at pH 2.6-3.0 for a malate dehydrogenase activity and at pH 3.6-4.0 for a malic enzyme activity. The decarboxylation of pyruvic acid yields CO_2, ethyl alcohol, acetoin and diacetyl. The L. plantarum can oxidize pyruvic acid. The acetoin produced by L. plantarum Strain "L" does not originate from L-malic acid.--Authors.

99187. FLEISCH, PETER, and BRIGITTE HOLBACH. (Pharmazeut. Inst., Johannes Gutenberg-Univ., Mainz, West Ger.) Zum Abbau der L-Äpfelsäure durch Milchsäurebakterien. Über die Malat-abbauende Enzyme der Bakterium "L" unter besonderer Berücksichtigung der Oxalessigsäure-Decarboxylase. [Degradation of L-malic acid by lactic acid bacteria. The malate-degrading enzyme of bacterium "L" with special consideration of oxalacetic acid-decarboxylase.] ARCH MIKROBIOL. 51(4): 401-413. Illus. 1965.--Qualitative and quantitative determination of enzyme activities in malic acid-lactic acid [illegible] strain "L" are discussed. Bacterium "L" contains a malic [illegible] among the malate degrading enzymes in addition to a malate-[illegible]decarboxylase. The oxalic acid decarboxylating action may not be related to the malic enzyme but to an independent oxalic acid decarboxylase. Free thiol groups are needed for the L-malic acid degradation by malic enzyme, but not for the oxalic acid decarboxylation. The Michaelis-constants of the enzyme substrate complexes of the enzyme differ significantly. The function of biotin was tested. While the CO_2-liberation from L-malic acid by malic enzyme from avidin is practically unrestricted, the restriction by the oxalic acid-decarboxylation is pronounced. The oxalic acid-decarboxylase from bacterium "L" probably produces a biotin protein.--Authors.

3276. FLEISCH, PETER, and BRIGITTE HOLBACH. (Pharm. Inst., Johannes Gutenberg-Univ., Mainz, West Ger.) Zum Abbau der L-Äpfelsäure durch Milchsäurebakterien. III. Über die Trennung der Malat-Enzym Aktivität von der Oxalessigsäure-Decarboxylase-Aktivität bei Lactobacillus plantarum L. [The degradation of L-malic acid by Lactobacillus. III. The separation of malic enzyme activity from oxalacetic decarboxylase activity in Lactobacillus plantarum "L."] ARCH MIKROBIOL. 52(1): 297-301. 1965.

[illegible] Cited, Samuel R., Walter F. Iverson, and Selman A. Waksman. Fungi. Dept. Soil., New Brunswick, N. J.) Effect of organic acids on streptomycin activity. *Proc. Soc. Exptl. Biol. and Med.* 67(2): 285-288. 1948.—*Pyruvic* and [illegible] acids neutralized to pH 7 stimulate growth of *Escherichia coli*. *E. coli* incubated with the organism to grow in the presence of 10 γ/ml. of streptomycin, whereas in the presence of 5% of these acids growth took place even with 100 γ/ml. of streptomycin. The organisms growing in the presence of streptomycin and of the organic acids would not become resistant to streptomycin. Certain other organic acids such as succinic, formic, malic and citric also had an antagonistic effect upon streptomycin. The effect of these acids varied greatly with the organisms. *E. coli* and *Proteus vulgaris* were protected by the organic acids against the action of streptomycin, whereas *Aerobacter aerogenes* and *Staphylococcus aureus* were only slightly affected.—*S. A. Waksman.*

24155. Harrell, [illegible]

6. FLORENZANO, GINO. (U. Florence.) L'azione di alcuni costituenti del vino sullo sviluppo della floretta. (The action of some wine components on the development of wine disease caused by Mycoderma and other molds.) Ann. Sperim. Agr. (Rome) 2(1): 79-93. 1948.--A wine of an alcohol content of 11%, a total acid content of 5.99 g./l. (fixed acids 4.67, volatile acids 0.82 g./l.) was pasteurized, and inoculated with Pichia membranaefaciens, Mycoderma sp., and a mixture of both. 0.1, 0.5, 1.5, 3 and 5%, respectively, of the following substances were added: glycerol, malic, lactic, succinic, and tannic acids. The activity of P. membranaefaciens differs from that of Mycoderma by a more pronounced destruction of alcohol by the former, and of fixed acid by the latter. The addition of glycerol inhibits both molds. In mixed inoculations, glycerol seems to impede the destruction of alcohol by Pichia and of fixed acids by Mycoderma. In the presence of glycerol, the production of acids is fostered in the case of Pichia, reduced in that of Mycoderma. Both molds are intensively stimulated in their development by malic acid. Pichia prefers fixed acids, Mycoderma alcohol as sources of C. Lactic acid inhibits Pichia, which, however, utilizes more fixed acids than alcohol; at the same time the production of volatile acids is hindered. In Mycoderma and in mixed inoculations mold development is fostered at the expense of more or less considerable amts. of alcohol. Succinic acid brings about in Pichia a lower consumption of alcohol, in Mycoderma of fixed acids. Tannic acid inhibits in both molds.--W. Bally.

[illegible] HUJER, [illegible] (L-PHOTO). Über die phytochemische Reduktion der Oxalessigsäure zu Äpfelsäure.

[illegible]. *Zeitschr.* 236(1/3): 231-236. 1931.--The difficulty in demonstrating this reaction was that the oxalacetic ester was readily decarboxylated by the yeast cells. The author used the diethyl ester of the oxalacetic ester and demonstrated the formation of the malic acid ester which was saponified to free malic acid. This demonstrated the reduction of a keto-acid ester by yeast.--*Z. I. Kertesz.*

12609. GORTNER, WINIFRED A. (Pineapple Res. Inst. Hawaii, Honolulu, Hawaii, U.S.A.) A short term effect of weather on the acid in pineapple fruit. Jour. Food Sci. 28(2): 191-192. 1963.--The malic-acid but not citric-acid content of pineapple fruit (*Ananas comosus*, var. Smooth Cayenne) was sensitive to changes in sunlight or conditions favorable to evaporation. The close inverse correlation between malic-acid and evaporation may be related to crassulacean-acid metabolism.--Author.

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17566. HAHN, ARNOLDUS, und W. HAARMANN. Über die Dehydrierung der Aepfelsäure. (Vorläufige Mitteilung.) [Dehydrogenation of malic acid.] *Zeitschr. Biol.* 83(1): 91-92. 1928.

14361. HAHN, ARNOLDUS, und W. HAARMANN. Über die Dehydrierung der Bernsteinsäure. [Dehydrogenation of succinic acid.] *Zeitschr. Biol.* 87(2): 105-111. 1928.—Fresh minced and washed horse muscle was mixed with neutralized succinic acid and methylene blue, the container evacuated, and then incubated at 38° for 3-7 hrs. From the fermentation mixture there were isolated malic acid as the lead salt and fumaric acid as the mercuro-nitrate. Results corroborate previous findings with heart muscle and resting bacteria and confirm the Thunberg theory that dehydrogenation of succinic acid in presence of methylene blue results in formation of fumaric acid, which then undergoes enzymatic hydration to malic acid.—*B. Cohen.*

14556. HUELIN, F. E., and I. MYFT STEPHENS. The copper-catalysed oxidation of ascorbic acid in fruit and vegetable juices. Australian Jour. Sci. Res., Ser. B, 1(1): 50-57. 1948.--The Cu-catalysed oxidation of ascorbic acid was studied in phthalate and phosphate buffers. The rate increased with concn. of Cu up to 10 parts per million and with increasing pH up to 6. Oxalic, malic, citric, and tannic acids, SO_2, albumen, cystein, and thiourea reduced Cu catalysis. Outstanding "protection" was given by thiourea. Most fruit and vegetable tissues contain substances which reduce Cu catalysis. Onion tissue gives outstanding "protection" against low concns. of Cu. Auth. summ.

5437. JACOBSOHN, KURT., and M. DEODATA AZEVEDO. (Inst. Rocha Cabral, Lisbonne, Portugal.) Adaptation fermentaire par induction asymmétrique. Note préliminaire. [Fermentative adaptation by asymmetric induction. Preliminary note.] Arch. Biochem. and Biophys. 69: 286-289. 1957.--Effect of D-malate on fermentative activities of Escherichia coli is reported.

13476. JACQUIN, P., and J. TAVERNIER. (Recherches Oenologiques et Cidricoles, Rennes, France.) Contribution à l'étude de la fermentation alcoolique des cidres et poirés. I. Métabolisme des acides organiques et modification du bilan acidimétrique. Résultats analytiques concernant les principaux produits secondaires de fermentation. II. Interprétation des résultats analytiques concernant les principaux produits secondaires de fermentation. [Studies on alcoholic fermentation in ciders and perries. I. Metabolism of organic acids and the modification of the acidimetric balance. Analytical results concerning the principal secondary products of fermentation. II. Interpretation of analytical results concerning the main secondary fermentation products.] Industr. Agric. et Alimentaires 68(11/12): 599-607. 1951; 69(2): 115-127. 1952.--I. Methods for the detn. of glycerol, sorbitol, esters and aldehydes are described. Tables showing analytical results are shown.--II. Ten perries, 16 ciders and 1 quince juice were studied. During fermentation malic acid was found to decrease. During this fermentation in ciders citric acid increases slightly. There is a notable loss of citric acid in perries and ciders during storage. Lactic and succinic acids are formed during the fermentation. Biological deacidification in ciders, but not in perries, after alcoholic fermentation leads to loss of malic and lactic acids. In fermented cider the order of acids in regard to abundance is lactic, succinic, acetic and malic. In the must malic acid accounts for 90-95% of the acids. In ciders, glycerol is present in smaller amts. after alcoholic fermentation than in wines. Esters are present and in the case of "raspberry disease" acetaldehyde is present. Ciders also contain sorbitol.

7197. KIDD, F., and C. WEST, D. G. GRIFFITHS, N. A. POTTER. (U. Cambridge, Eng.) Metabolism of malic acid in apples. Jour. Hort. Sci. 26(3): 169-185. Illus. 1951.--This study is based upon expts. which were carried out for several yrs. on Bramley Seedling and Worchester Pearmain vars. The data and methods of analysis have already been published in full in the Jour. Hort. Sci. (1950). The observations made in these expts. were on the total titratable acidity of apples which were removed from the tree at different stages of development and which were stored at different constant temps. At all temps. of storage there was no loss of acid during an initial period after gathering, a period which at 10°C may last for as long as 3 weeks. This period in which there was no loss is termed the delay period. The data fall into a single pattern which leads to the following generalizations; after gathering

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is a delay period of varying length during which acid
as unchanged, subsequently decreasing in amt. at a rate
tional to the concn. of acid present; the rate constant
loss does not change appreciably with the stages of
and appears to be a physiological characteristic of the
The loss of acid which takes place in gathered fruit is
idered to be due to decarboxylation which does not require
esence of free oxygen. The formation of acid on the tree
sidered to be due to a process requiring the presence of
and to be linked with the system involved in cell formation.
--T. H. McHatton.

[illegible] (Fed. Exp. Sta., Australian Hill Dairy, [illegible]) [illegible] for acidity determination in grape musts and wines]. BIOCHIM BIOPHYS ACTA 85(3): 491-492. 1964.

173. KREBS, HANS ADOLF, DAVID HENRY SMITH, and EARL ALISON EVANS, Jr. Determination of fumarate and malate in animal tissues. *Biochem. Jour.* 34(7): 1011-1015. 1 fig. 1940.—Fumarate is reduced to succinate in the presence of Zn and phosphoric acid and the succinate formed is detd. manometrically with succinic dehydrogenase. The conc. of l(−)malate is calculated from the equilibrium constant. At pH 7.4 the ratio l(−)malate/fumarate was 2.65 at 50°, 3.17 at 40°, 3.51 at 30° and 4.57 at 20°.—*Auth. summ.*

19810. KROTKOV, G., D. G. WILSON, and R. W. STREET. (Queen's U., Kingston, Ont., Canada.) Acid metabolism of McIntosh apples during their development on the tree and in cold storage. Canadian Jour. Bot. 29(1): 79-90. 1951.--From the time of fruit setting early in the spring and throughout the summer, samples of fruit were taken from the tree. In the fall several bushels of apples were placed in cold storage. Samples of fruits were analyzed weekly for pH and titratable acidity and for organic acid. Stages in the acid metabolism of fruits were found to correspond closely with those of carbohydrate and respiration. During the first 2-4 wks. of the fruit ontogeny, the pH of apple juice falls rapidly to a value of about 2.8. Thereafter there is a slow, steady rise which continues until the next spring. This regularity makes the pH of the juice a better indicator of the physiological age of a fruit than either its chemical composition or respiratory rate. Initially, the malic acid content of a fruit is low, and some unknown organic acids predominate. This relation is reversed within the first 2-4 wks. of growth and during the rest of the ontogeny malic acid forms about 80% of the total organic acids of a fruit.--Auth. summ.

[illegible] (New York State Agric. Expt. Sta.

23357. LAMDEN, MERTON P., and ROBERT S. HARRIS. (Massachusetts Inst. Technol., Cambridge.) Browning of ascorbic acid in pure solutions. Food Res. 15(1): 79-89. 1950.--Model mixtures containing pure ascorbic and citric acids were used to study the effect of heating on the development of color and loss of ascorbic acid. The water of crystallization in the citric acid promoted the browning of a powdered mixture of ascorbic acid and citric acid at 49°C. Ascorbic acid-citric acid solns. which contained increasing amts. of citric acid and were heated for 3 hrs. at 100°C showed increasing optical densities at 410 mμ and decreasing ascorbic acid contents. When heated at 100°C, ascorbic acid solns. containing malic, tartaric or oxalic acid also developed color. Neither color formation nor loss in ascorbic acid depended on the presence of O_2 during the heating. SO_2 prevented the formation of the color, but probably not as an anti-oxidant. Color formation was a function of the initial ascorbic acid content. On boiling, furfural was formed in an ascorbic-citric acid soln., but not in a dehydroascorbic acid soln. Upon heating an ascorbic-citric acid soln. at 60°C., O_2 was consumed and CO_2 was evolved at a linear rate. Approx. half of the CO_2 theoretically obtainable by ascorbic acid destruction was recovered. The remainder may have been present in transformation product or in products not yet decarboxylated. No measurable decomposition of citric acid occurred during browning process. The rate of loss of ascorbic acid in the highly acidic solns. indicated that the reaction was monomolecular. The bearing of these results upon the browning reaction in dehydrated citrus products is discussed.--Merton Lamden.

(Purdue U., Lafayette, Ind.) A role for malic acid in tomato fruit-set. Arch. Biochem. and Biophys. 41(1): 61-73. 1952.--Studies were made with excised flowers of a self-sterile strain of John Baer tomatoes. Malic acid, glutathione, and $MnSO_4$ each and collectively increased tomato fruit-set. Of all the compounds known to promote fruit-set, only malic acid appreciably increased fruit-set in the presence of glutathione and $MnSO_4$. These findings suggest that the promotion effect of the 3 compounds in combination may be due to the decarboxylation of malic acid by malic decarboxylase. The addition of 2 of the products of the malic decarboxylation reaction (CO_2 and pyruvic acid) each quantitatively inhibits fruit-set in the presence of malic acid, glutathione, and $MnSO_4$. The addition of ascorbic acid with the 3 latter compounds further increases fruit-set. These promotive and inhibitory effects suggest that the decarboxylation of malic acid may be beneficial to fruit-set in the tomato. It is suggested that the beneficial effect of this system may be through the activation of a series of linked oxidation-reduction reactions.--A. C. Leopold.

3974 HARROW, ARTHUR F., and F. E. DEATHERAGE. (Ohio State U., Columbus.) Organic acids in brewed coffee. Food Technol. 10(4): 191-197. 1956.--Using partition chromatography, the organic acids of 5 coffee extracts were determined. The predominant acid was chlorogenic; the least in evidence was acetic acid. Caffeic, pyruvic, oxalic, malic, citric, and tartaric acids were present. The role of chlorogenic acid in the flavor of brewed coffee warrants further investigation.--Authors.

A18691. HACKLOH, A. E. S., and P. C. DeTOCK. (Macaulay Inst. Soils, Aberdeen, Scotl., UK.) Physiological gradients in the potato tuber. PHYSIOL. PLANT. 20(3): 421-439. illus. 1967.--The distribution of the major cations and anions, together with citric acid, malic acid and iron, has been studied in tubers of Solanum tuberosum cv. 'Golden Wonder,' by analysis of longitudinal cores divided into 16 equal cylindrical sections. In immature daughter tubers the constituents studied were evenly distributed along the tuber, but in mature tubers a considerable polarity had developed. The concentrations of K, P and citric acid each rose from the heel to the rose end of the tuber. Fe showed a gradient in the opposite direction. These gradients were maintained in sprouting tubers, and although after 25 days the levels of these constituents were reduced, the patterns of distribution were unchanged. In the exhausted mother tubers all these constituents were much depleted and only K exhibited any pattern of polar distribution. Malic acid was barely detectable at any stage, and Ca, Na, Mg, Cl, sulfate and nitrate were always at low levels and showed no polarity of distribution. At each developmental stage K was correlated with the difference in electrical potential measured between cells at points across the tuber. A close correlation was apparent between K and citric acid content in young, mature and sprouting tubers. In all stages a considerable discrepancy existed between total anions and total cations and this was attributed to the presence of organic acids other than citric acid.--Authors.

HARKLEY, K. S., and CHARLES E. SANDO. Progressive changes in the cuticle of apples during growth and storage. *Jour. Agric. Res.* 46(6): 481-512. 1933.--Further studies on the changes in the waxlike coating on the shady side of the apple during growth and storage were made on varieties grown in 2 or similar apple regions (Wenatchee Valley, Wash., and the Lake district of New York). A method for the quantitative determination of cutin, present in the cuticle of apples, was devised and used. In confirmation of previous results obtained from fruit grown near Washington, D. C., it was found with New York and Washington fruit that quantities of malic acid, oily fraction, and total ether extract at maturity and at the end of the storage period were greater than in the early stage of growth and that the quantities of the constituents increased from the time of picking to the end of the storage period. With advancing maturity there was in general a progressive increase in the percentage of the oily fraction in the total ether extract. Quantities of cutin were greater at maturity and at the end of the storage period than in the early stage. The proportion of total ether extract to cutin varies considerably in individual varieties, but when these substances representing the mature stage are averaged for the varieties for which complete data are available, the ratio of total ether extract to cutin is about 44:56, indicating that the cuticle of apples, which constitutes the main outer protective coating, is composed of approximately 44% of ether-soluble constituents and 56% of ether-insoluble cutin. In considering comparable apples from each locality as a group, New York fruit in 1929 had higher amounts of malic acid, oily fraction, and total ether extract at the mature stage and at the end of the storage period than did Washington apples. Individually the same varieties from the 2 localities varied somewhat with respect to quantities of constituents. Data are given showing the quantities of constituents and percentage of oily fraction in the total ether extract at picking maturity for all varieties collected from 2 or more localities and the average daily rates of deposition of total ether extract for most of the varieties. These values may possibly be characteristic of varieties, since they reflect differences in quantities of total ether extract due to environment and hereditary tendencies independent of the length of growing season.—*K. S. Markley and C. E. Sando.*

HAUNEY, J. R. (Cotton Res. Cent., Phoenix, Ariz., USA.), JEAN CHAPPELL, and E. J. WARD. Effects of malic acid salts on growth of young cotton embryos in vitro. PHYTOPATH. 47(6): 383-390. illus. 1957.--Chromatographic analysis of the fluid endosperm from 12- to 14-day-old cotton ovules indicated the presence of malic acid in excess of 7 mg/ml. Addition of 4 mg of ammonium or calcium malate to each ml of culture medium resulted in more rapid growth and greater viability of cotton embryos cultured in vitro from the heart stage. Sodium malate in excess of 0.01 mg/ml inhibited embryo growth in vitro. Ammonium or calcium citrate and succinate were either less effective than malate in supporting embryo growth or inhibitory.--Authors.

539 MAYER, ADOLF. Die Sauerstoffabscheidung aus Sukkulenten bei Abwesenheit von Kohlensäure.

[The elimination of oxygen from succulents in the presence of carbon dioxide.] *Jahrb. Wiss. Bot.* 65(1): 636-673. 1926.—The view generally held to be in text books of plant physiology, that in the night the supply of malic acid in the leaves of Crassulaceae and similar plants decomposes, forming CO_2, which in the next day's photosynthesis, is criticized. Respiration is too slow to furnish nutriment for the assimilation process and the formation of malic acid is a part of the photosynthetic process, being indeed an evanescent intermediate product in the ordinary assimilation process.—*E. F. Hopkins.*

METABOLISM

1690 McColl, Elizabeth R., and John D. Guthrie. The organic acid content of raw cotton fiber. Isolation of l-malic acid and citric acid from cotton fiber. *Jour. Amer. Chem. Soc.* 67(12): 2220-2221. 1945.--Raw cotton fiber contains about 0.5% *l*-malic acid and 0.07% citric acid. The presence of both of these acids in raw cotton fiber has been definitely established by isolating them in crystalline form.—*S. B. Mecca.*

1316. LÖHZ, Till. (Chem. Abt., Brauerei, Austria.) Über die [illegible] von Eisenfällen bei [illegible] Wein und Apfelsaft. [The [illegible] of iron [illegible] with [illegible] and filtrates with [illegible] calcium [illegible] on [illegible] of wine and [illegible]] Weinberg u. Keller 9:61-69. 1962.

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19767. FREEDMAN, DOROTHY MOYLE. A quantitative study of succinic acid in muscle. II. The metabolic relationships of succinic, malic, and fumaric acids. *Biochem. Jour.* 21 (3): 739-750. *2 fig.* 1927.—A method is worked out for estimating malic acid in muscle, and for total succinic, fumaric and malic acids taken together. When minced muscle, suspended in buffer solution, is placed alternately under anaerobic and aerobic conditions, the succinic acid content rises in N, falls in O, rises again in N, and so on. With similarly repeated changes of atmosphere, total succinic, malic, and fumaric acids taken together rises in anaerobiosis and falls in aerobiosis. Malic acid is highest in fresh muscle (about 12–15 mgm. per 100 gm.); it falls to practically 0 in N, and on admission of O it may rise, but very slightly. When succinic acid disappears in O it is oxidized further than to fumaric and malic acids; and when the succinic acid maximum is renewed in N, the latter acid is formed from some other source than reversibly from fumaric and malic acids. The results also suggest that production of succinic acid is hindered by accumulation of the acid and make possible the hypothesis that in vivo production and oxidation go on continuously.—*D. M. Needham.*

cont

27123. PALMER, JAMES K. (Connecticut Agric. Expt. Sta., New Haven.) Chemical investigations of the tobacco plant X. Determination of organic acids by ion exchange chromatography. Bull. Connecticut Agric. Expt. Sta. 589: 1-31. Illus. 1955.--A technique is presented for the rapid, precise, and accurate detn. of malic, citric and total nonvolatile organic acids in water or ether extracts of dried tobacco leaf tissue. The acids are separated by chromatography on anion exchange resins (Dowex 1-X10, formate) by the use of gradient elution with continuously increasing concns. of formic acid. The quantity of organic acid in each of the fractions of effluent is detd. by titration of the residue that remains after evaporation of the eluting agent in a stream of air at 45-48°C. The entire ion exchange procedure requires only about 4 hours. A statistical comparison of the results obtained with this method with those obtained by previously used techniques shows ion exchange chromatography to be superior for the detn. of malic acid and of total acidity. Results for citric acid are of about the same precision and accuracy as those by earlier methods. The separation and detn. of many other organic acids of interest in metabolism is also possible with the formate system, and modifications can readily be introduced to make the method suitable for application to any plant tissue which can be suitably prepared. As evidence of this possibility, authentic samples of a wide variety of acids including glutamic, aspartic, glycolic, succinic, glyoxylic, tartaric, pyruvic, fumaric and maleic acids have been tested and recoveries in the range of 97-102% have been obtained. A number of plant tissues and commercial products have been analyzed as a preliminary trial of the general applicability of the method. Anion exchange chromatography on Dowex 1 in the acetate form with continuously increasing concns. of acetic acid as the eluting agent makes possible the separation of several fast moving organic acids which are eluted as mixtures from the formate column. Preliminary analysis on the acetate resin of the fast moving organic acids of the tobacco leaf provides evidence that there are seven or more components in the "undetermined acids" fraction. Ion exchange chromatography is shown to possess a number of advantages over partition chromatography on silica gel for separation of the acids of biological interest. A simple and rapid (2 hrs.) paper chromatographic technique is also described which aids in identification of acids eluted from the ion exchange resin.--J. K. Palmer.

27724. BEUSTRUEVA, S. N. (V. I. Ulyanov-Lenin Kazan State Univ., Kazan, USSR.) Vliyanie ammiaka na prevrashchenie glyukozy, alanina i yat bichnoi kisloty v listyakh pshenitsy. [Effect of ammonia on the transformation of glucose, alanine and malic acid in [illegible] leaves.] FIZIOL. RASTEN. 15(5): 785-791. 1968. [Eng. sum.]--Sunflower plants were kept 5 min in an atmosphere containing ammonia in concentrations of 1: 1000, 1: 500 and 1: 100; the leaves were infiltrated with C^{14}-labelled glucose, alanine and malic acid and then exposed to light for 1 hr. Incorporation of the label into water and alcohol-insoluble and soluble compounds was studied. Two-dimensional paper chromatography and autoradiography were employed for investigating the soluble compounds. For ammonia concentrations of 1 : 500 and particularly 1 : 100, incorporation of the label from the investigated compounds into the water and alcohol-insoluble compounds decreased; transformation of alanine and malic acid into carbohydrates also decreased. Ammonia leads to greater violation of operation of the Krebs cycle than of glycolysis. Acceleration of formation of alanine from glucose induced by ammonia is regarded as an adaptive reaction.--M. K.

6325. PALMER, M. J. (Macaulay Inst. Soil Res., Aberdeen, Scot.) [illegible] influence of illumination on the malic-acid content of the leaves of [illegible] (Compositae). INT CONGR BIOCHEM 6(10): 765. 1961. --Abstract only.

16331. PALMER, M. J., P. C. DeKOCK, and J. S. D. BACON. ([illegible] Inst. Soil. Res., Aberdeen, Scotland.) Changes in the concentrations of malic acid, citric acid, calcium and potassium in the leaves during the growth of normal and iron-deficient sunflower plants (Compositae). Biochem. Jour. 86: 484-491. 1963.--Sunflower plants (*H. annuus*) were grown in soil and on various nutrient solutions. Measurements were made of the major leaf anions, malate and citrate (and occasionally also of ascorbate, nitrate and phosphate), and of certain cations (Na, K, Ca and Mg.) While green the leaves accumulated malic acid and Ca in equivalent amounts under most of the conditions studied. The content of citric acid, and of K, Na, and Mg changed relatively little. The content of malic acid was lower than that of Ca in Fe-deficiency and in conditions of poor illumination. It was depressed by a high K/Ca ratio in the nutrient solution, but not to the same extent as the Ca content. The content of citric acid was increased by Fe-deficiency, but not much affected by other variations in conditions. Usually the sum of the content of malic acid and citric acid balanced the sum of the principal cations, Ca and K; but when the malic acid content was depressed a discrepancy existed that could only partly be explained by accumulation of nitrate. When the leaves turned yellow the content of malic acid fell and that of citric acid correspondingly until it became the major component. There were no consistent changes in the Mg content. The results are discussed with special reference to the significance of the K/Ca and citric acid/malic acid ratios in normal and deficient leaves.--Authors.

...Aberdeen, Scot., U.K.) The effect of illumination... [illegible] content and relationship between [illegible] of malic acid. [illegible] 10(1): 301-312, illus., 1961.--... have been given under conditions in which the length of artificial day could be controlled. Leaf samples were analyzed for malic acid and citric acid, and for a number of inorganic cations and cations. A simple method is described by which sap was obtained from ... leaves of 16 hr, or more, malic acid was ... The chief ... decreased considerably but ... There was little change in the pH ... the balance of cations and anions having been maintained mainly by increases in citrate and nitrate contents. Analyses of the whole leaf still showed some deficiency in cation after Na, K, Ca, Mg, nitrate, sulphate, inorganic phosphate, chloride, malate and citrate had been accounted for. Analyses at shorter intervals revealed a large diurnal variation in malic acid content, which increased during the first 5-6 hr. of the light period, and fell during darkness. The significance of these findings is discussed, and it is suggested that malic acid accumulation is a by-product of photosynthesis, Ca being taken up irreversibly to maintain anion/cation balance, and hence creating a continuing need for anions to balance it.--Authors.

2917. PEYRAUD, E., and J. BLONDEL. (Sta. oenol. et oenologique, Pont-de-la-Maye, France.) Comparaison de quelques méthodes de dosage de l'acide L-malique. [Comparison of some methods of quantitative determination of L-malic acid in wine.] ANN. TECHNOL. AGR. [Paris] 10(1): 61-66. 1961. [Engl. summ.]--Auth. summ.

30172. PEYRAUD, E., S. DOUBROCQ, A.-H. BOUDROU, S. LAVOLAY-LAFOURCADE, and G. GUILHEMAIN. (Lab. Agron. Etud. Recherches, France.) Etude de la levure Schizosaccharomyces octosporus Beij. et Pacl. I.--L'acide malique. [Study of Schizosaccharomyces yeasts and malic acid.] ANN. TECHNOL. AGR. [Paris] 16(2): 159-165. illus., 1967.--The authors studied L-malic acid formation as a possible basis for "natural" classification of Schizosaccharomyces spp. With this property as the determining factor, no distinction could be made between S. pombe (found on tropical fruits with anaphoxous pulp) and S. octosporus (found on temperate fruits with alkaline pulp) and these 2 spp. would be considered as synonyms.
--From auth. summ. transl.

6379. PHILLIPS, M., F. D. WILKINSON, and A. M. BACOT. (Production and Marketing Admn., U.S.D.A., Washington 25.) The chemical composition of certain grades of Puerto Rican tobacco, Type 46. Jour. Assoc. Offic. Agric. Chemists 36(4): 1157-1165. 1953.--The percentages of the following constituents of 13 grades of Type 46 tobacco from which the midribs were removed were reported: ash, water-soluble and water-insoluble ash, chlorine, petroleum ether extractives, total N, nitrate N, ammonia N, protein, nicotine, total reducing substances (as glucose), pectic substances, pentosans, cellulose, lignin, oxalic, citric, and L-malic acids. Comparisons between the composition of light bodied and heavy bodied grades are discussed.
--C. R. Richards.

25115. Pierce, Elwood C., and C. O. Appleman. (*U. Maryland.*) Rôle of ether soluble organic acids in the cation-anion balance in plants. *Plant Physiol.* 13(2): 221-229. 1938.--12 spp. of plants were grown in solution culture and all received the same nutrient supply. The cation-anion balance in the different spp. was studied. Inorganic ions were taken up in varying proportions according to inherent characteristics of the plant. Plants in the same family tended to accumulate ions in relatively the same proportions. In all of the plants studied, except cantaloupe, there was a large excess of inorganic cations over inorganic anions and this excess was highly correlated with total ether soluble organic acids. In the leaves malic and citric acids showed a rather low positive correlation with soluble Ca. Citric acid and these acids of the unknown group showed a small negative correlation with total Ag content in the stems and petioles. Insoluble oxalate and insoluble Ca were highly correlated when the plants were considered as a group. In 3 cases insoluble oxalic acid exceeded the acid. of insoluble Ca. The data indicate that the additional insoluble oxalic acid was present as Mg oxalate. Those plants with little or no oxalic acid had a large proportion of the Ca in a sap soluble state, while those plants high in oxalic acid had but traces of sap-soluble Ca.--C. O. Appleman.

7235. PLATITSYNA, N. P. Effect of some organic acid salts on storage of citric acid by leaves of tobacco plants. *Compt. Rend. (Doklady) Acad. Sci. U. R. S. S.* 72(1): 57-59. 1950.--Leaves of *Nicotiana rustica* and of *N. glauca* were sterilized by EtOH and H_2O_2, and the petioles submerged in 0.25 *M* solns. of Ca or K salts of various org. acids. After 2 days the leaves were cured by storing in the dark over solid NaCl. They were then analyzed in comparison with controls which had been kept in water only. Calling the citric acid in the controls 100, that in a typical series of *N. glauca* was: tap water, 253; KCl, 224; K tartrate, 140; K malate, 545; K fumarate, 402; K succinate, 561. Similar results are recorded for 2 series each with *N. glauca* and *N. rustica*. It is concluded that the increase in citric acid in tobacco leaves during curing is at the expense of the malic acid.—*J. J. Willaman* (*courtesy Chem. Abst.*).

2905. QUASTEL, J. H., and A. H. M. WHEATLEY. Biological oxidations in the succinic acid series. *Biochem. Jour.* 25(1): 117-128. 1931.—There is quantitative evidence that the normal course of biological oxidation of succinate proceeds largely, if not entirely, through fumarate and *l*-malate. The evidence results from: a comparative study of the oxidations of fumarate and *l*-malate in presence of various organisms and tissues; a comparison of the action of malonate and of oxalate on the oxidation of fumarate and *l*-malate; and measurements of *l*-malic acid formed from succinic acid, the observed and calculated quantities being in close agreement. Fumarate and *l*-malate inhibit the oxidation of succinate in presence of various bacteria and of muscle and brain tissues. The strict aerobes *B. alkaligenes, B. subtilis* and *M. lysodeikticus*, and also muscle tissue, attack *l*-aspartate in a different manner from the facultative anaerobes *B. coli, B. proteus* and *B. acidi lactici*. The latter oxidize the acid through fumaric and *l*-malic acids. Malonate not only inhibits the oxidation of succinate by bacteria but also that by muscle and brain tissues, the degree of inhibition being greatest with these tissues. The wide variation with different cells in the degrees of inhibition by malonate is associated with differences between velocities of oxidation of fumarate and those of succinate. Neither malonate nor oxalate inhibits the velocity of oxidation of *p*-phenylenediamine by brain tissue. These results are discussed in relation to Warburg's views on the "respiration enzyme" of the cell.—*Author's summary.*

2906. REID, ALBERT. Das saurezerstörende Ferment der Atmung. [The oxygen carrying enzyme of respiration.] *Ergeb. Enzymforsch.* 1: 325-341. 1932.—A review.

† 61563. QUEIROZ, ORLANDO. (Lab. Phytotron, Centre Nat. Rech. Sci., Gif-sur-Yvette, Fr.) Sur le métabolisme acidique des Crassulacées: II. Action à long terme de la température de jour sur les variations de la teneur en acide malique en jours courts. [On the acid metabolism of Crassulaceae: II. Long term action of the day temperature on variation in malic acid volume in short days.] PHYSIOL. VEG. 4(4): 323-339. illus., 1966. [Engl. summ.]--Plants of Kalanchoe blossfeldiana from Thimb'placed under short day conditions at different day temperatures (between 2°C and 32°C) but at the same night temperature (17°C), have shown that the temperature during the first period has a marked effect on the synthesis of malic acid during the following dark period; after 20 short days the plants at 27°C during the day synthesized about 3 times more malic acid during the night than the plants at 17°C and about 17 times more than those at 12°C. The quantity of malic acid present at the end of the night in the young leaves is an exponential function of the number of short days affected by a parameter which is itself a function of the day temperature. But this law is true only after a complex adaptation process whose running varies with the thermoperiod. The fall in the content of malic acid in the light is a linear function of the content attained at the end of the dark period, this law being the same for all temperatures studied. The capacity for the accumulation of malic acid is then in a direct ratio with the augmentation of the dark-period synthesis. This action of the thermoperiod under short day conditions also causes changes in the quantities of citric and isocitric acids whose relative proportions are modified according to the temperature and length of the treatment.--Author.

12270. QUEROZ, ORLANDO. (Lab. Phytotron, Cent. Nat. Rech. Sci., Gif-sur-Yvette, Fr.) Action de photopériodisme sur l'activité enzymatique dans la synthèse ou la dégradation de l'acide malique chez *Kalanchoë blossfeldiana*. [Effect of photoperiodism on the enzymatic activity in the synthesis or the degradation of malic acid in *Kalanchoë blossfeldiana*.] C R HEBD SEANCES ACAD SCI SER D SCI NATUR 266(12): 1260-1262. Illus. 1968[recd. 1968].--The activity of phosphoenolpyruvate (PEP) carboxylase and that of the malic enzyme increases rapidly when plants receive an increasing number of short days; simultaneously, there is a development of a circadian rhythm of enzymatic activity of growing amplitude. The interruption of the night by a brief red lighting hinders this action. A hypothesis is proposed for the mechanism of this process.--A. C. S.

27232. RIBEREAU-GAYON, G. (Lab. Oenol. Chim. Agr., Fac. Sci., Talence, Fr.) Etude des mécanismes de synthèse et de transformation de l'acide malique, de l'acide tartrique et de l'acide citrique chez *Vitis vinifera* L. [Study of the mechanisms of synthesis and transformation of malic, tartric and citric acids in *Vitis vinifera* L.] PHYTOCHEMISTRY 7(9): 1471-1482. Illus. 1968.

1906. Ribereau-Gayon J., et E. Peynaud. Sur la formation des acides acétique, lactique et citrique au cours de la fermentation alcoolique. *Compt. Rend. Acad. Sci. [Paris]* 232: 457-459. 1916.--Acetic acid is formed at the beginning of alcoholic fermentation of sucrose by yeasts isolated from wines in the Bordeaux region; it is later reduced to ethyl alcohol rapidly, since yeasts have a greater reducing power and poise the oxidation reduction potential at a lower level; acetic acid is reduced more readily when cysteine is present. Citric acid also originates from the sucrose, either from cane sugar, or in wine must during fermentation; malic acid, originally present in must, is rapidly converted to alcohol and CO_2, presumably via the intermediate stages of oxalacetic acid and acetaldehyde.—*J. Dufrenoy.*

27610. RIPPEL, K. Der biologische Saureabbau im Wein. [The biological decomposition of acids in wine.] Arch. Mikrobiol. 14: 509-530. 1949.--The extent of the biological decomposition of acids in the wine is dependent on the quality of the grapes. The richer the latter are in agents (biocatalysts) vital to Bacterium gracile, the more intensive is the decomposition of malic acid in the wine. The decomposition of malic acid by B. gracile is an oxidation-reduction which proceeds more or less anaerobically or aerobically, according to the environmental conditions. Solely with the aid of the aerobic phase, B. gracile supplies its caloric requirement, while the development of the lactic acid from the malic acid is of endothermic character in its anaerobic course. The buffer capacity of the wine is very high. The higher the buffer capacity, the lower the range of reaction regulation. In the wine it is almost double the range of the grape juice. Apparently many reaction-regulating constituents, organic as well as inorganic, are absorbed by the yeast-metabolism during fermentation. Also the yeast presumably resorbs part or the whole of the agents vital to B. gracile; that is why the decomposition of the acids sometimes begins only after the autolysis of the wine yeast.--A. Lemaire.

14485. Rippel, Karl. Der bakterielle Abbau der Äpfelsäure im Wein als Folge biologisch aktiver Wirkstoffe (bio-katalysatoren) in den Weinbeeren. *Ber. deutsch. bot. Ges.* 30: 105-117. 1912. The destruction of malic acid in wine by *Bacterium gracile* is dependent on the... factor (bio-catalyst) present in the grapes, the amount varying from lot to lot. The chemical nature of this factor is unknown, as are the conditions which contribute to its formation in the grapes. Neutralization of the acidity of the fermentation, with $CaCO_3$, incurs neither the amount of destruction of malic acid nor the development of the bacteria; on the contrary, such neutralization tends to decrease the destruction of malic acid.—*Garrett Hardin.*

...ysiol. Anz. ... 8 JULY-AUG., 1929] PLANT PH...

...molecule ... 150] RUHLAND, W., und K. WETZEL. 208
...more ... Zur Physiologie der organischen Säuren in grünen Pflan-
...of this ... II. Rheum hybridum Hort. Vorläufige Mitteil-
...sis of ... Organic acids in green plants. II. *Rheum hybridum*
...can be ... *Zeitschr. Wiss. Biol. Abt. E, Planta* 3 (1): 79-...
...ost of ... 97.—In accordance with the view that the
...ntine de... acids are formed as by-products whenever
Nicotine ... ...ation occurs, the garden rhubarb is classified
...be influ... ...id and "ammonia plant." Analytical data
Light i... ...to show that in these portions of the rhizome,
...ect the ... ...and developing leaf where ammonia N accumu-
...of very... ...late is a parallel accumulation of succinic and
...itrogen ... ...acids, the latter serving as the parent material
...not a pr... ...of the acid. Volatile acids and lactic acid occur in
...ounger ... ...The soluble N fractions arising during periods
...m incre... ...of metabolism in rhubarb contain large quanti-
...tion cent... ...ties ammonia N and relatively small amounts of
...vovable... ...amino-N.—*O. Schultz.*

5443. RUHLAND, W., und K. WETZEL. Zur Physiologie der organischen Säuren in grünen Pflanzen. V. Weitere Untersuchungen an Rheum hybridum Hort. (Vorläufige Mitteilung.) *Zeitschr. Wiss. Biol. Abt. E, Planta* 7 (4): 503-507. 1929.—The chief results of an extended investigation of the metabolism of rhubarb, details of which are to be published later, are summarized. When the rhizome sprouts a deamination of the amino acids moving into the stems takes place and for every mol of NH_3 liberated one mol of *l*-malic acid is formed. The acid present in other parts of the plant is the inactive form. Oxidation of malic acid proceeds only to oxalic acid.—*L. P. Miller.*

60703. SAI, TOSHIYUKI. (Cent. Res. Lab., Asahi Brew. Ltd., Tokyo, Jap.) Studies on (-)-ethanolic acid formation by respiration-deficient yeast mutants. III. Some environmental factors affecting ethanolic acid formation. HOSAKA, HIROSHI 42: 35-42. Illus. 1966.
Effects of some environmental factors on the accumulation of ethanolic acid (CM) by several respiration deficient (RD) mutant strains of Saccharomyces carlsbergensis and S. cerevisiae were studied in fully defined media. CM was accumulated during fermentation parallel to the amounts of glucose consumed. CM also was produced from other carbohydrates such as sucrose, maltose, fructose, galactose and mannose. The amounts of CM formed by the 9 RD strains under aerobic conditions, shaking, were only 1/5 to 1/2 of those under anaerobic conditions, showing repression of CM formation by O_2. The respiration-competent parent strains, however, could not accumulate CM even when they were grown under strictly anaerobic conditions or in the presence of respiratory inhibitors such as antimycin A and acriflavine. The relationship between the respiratory deficiency and the CM-forming property of yeast cells are discussed.--Author.

12631. SASAKI, YUJI, and SHIOCHI TAIZO. (Fac. Agr., Hokkaido Univ., Sapporo, Japan.) Organic acid production by oxidation ponds. III. Cultural conditions for fumaric acid production. ZENTRALBL BAKT. PARASITENK. INFEKTIONSKR. HYG. Abt. II. 15(2): 373-377. 1967.--Cultural conditions were examined for the purpose of increasing yields of fumaric acid by the Rhizopus sp. Sch-1 medium composed of sucrose, ammonium sulfate, yeast extract, KH_2PO_4, $MgSO_4 \cdot 7H_2O$, and $CaCl_2$ was found to produce the acid at a maximum level in CaCO3 containing cultures. The most favorable nitrogen sources were $(NH_4)_2SO_4$ and urea. Effective concentrations of inorganic salts in the medium were 0.2% KH_2PO_4, 0.05% $MgSO_4 \cdot 7H_2O$, and 0.05% NaCl, and optimal concentrations of sugars were 5 to 10%. Several nonionic surface-active agents promoted fumaric acid production by growth of the fungus and increased sporulation. In particular, Tween 80 in the medium was effective for fumaric acid production. Of malic acid production by the organism, a yield of over 50% based on available sugar was obtained after 10 to 14 days. Fumaric acid production by the mutant was stimulated by addition of Carbowax 4000 (polyethylene glycol), and the resultant yield was more than 40%.--Author's abstract.

... SASAI, YUJI, and SHOICHI TAKAO. (Fac. Agr., Hokkaido Univ., Sapporo, Jap.) Conversion of fumaric acid fermentable to malic acid fermentation by the association of Rhizopus and yeast. II. Conversion of fumaric acid through cell membrane factors in Rhizopus cell and yeast cultures. *J. Ferment. Technol. (Japan)* 40(3): 190-195. Illus. 1962. [In Jap.; 7th Engl. summ.]--In order to continuously convert fumaric acid fermentation by the genus Rhizopus to L-malic acid fermentation, P. neoformans factors having a high fumarase activity was combined with the culture of R. chinensis. In stationary culture, when R. chinensis was incubated in glucose medium containing $CaCO_3$ for 14 days, then associated with P. neoformans for 5 days, 80% of fumaric acid produced by the Rhizopus before addition of the yeast was converted to malic acid. In this case, final yield of malic acid based on available glucose was 30.7%. However, shake culture or reciprocal shaker was much more favorable than stationary culture for the conversion of this fermentation, because the fermentation period was reduced and acid yields were extremely increased. In shake culture, some surface active agents were effective on preventing the mycelial pellet development of R. chinensis which resulted in low acid yields, especially the addition of Carbowax 4000 (polyethylene glycol), 10% to the medium, was most suitable for good growth and high acid production. When R. chinensis was shake-cultured in the Carbowax-containing medium for 5 days, then combined with P. neoformans for 5 days, 95% of fumaric acid previously produced by R. chinensis was converted to malic acid by the action of the yeast and malic acid yield of as high as 62.5% was finally obtained. --Authors.

53007. SCHRAMM, R. W., TERESA MOSSOR, and C. GIERCZAK. (Dept. Biochem., A. Mickiewicz Univ., Poznan, Pol.) Influence of light on the content of citrate and malate in germinating seeds and young seedlings of horsebean (Vicia faba L. minor). *ACTA BIOCHIM POL.* 14(3): 303-311. Illus. 1967.--The light affects in a much higher degree the changes in citrate and malate content in the seedling's axis (shoot and root) than in the cotyledons. During seed soaking, citrate is used by the germ. In the period of protrusion of the germ and its further development, the content of citrate in the seedling's axis increases and then decreases, whereas the content of malate increases steadily. Malate is partly transferred from the cotyledons to the seedling's axis during the 1st stage of germination. After the beginning of photosynthesis, the increase in malate in the roots derives from the photosynthesis products. In the cotyledons, the content of citrate and malate in relation to the dry weight is almost unaltered during germination.--Authors.

3231. SHIMOSE, FUMIA, and ISAO AOZASA. On "Kaen" containing sodium malate. [In Japanese.] *Rikwagaku-Kenkyū-Jo Hō (Bull. Inst. Phys. and Chem. Res.)* 12(7): 607-613. 1933. [English abstract] Abstr. from *Rikwagaku-Kenkyū-Jo Hō (Bull. Inst. Phys. and Chem. Res.)* 12(7): 73. 1933. (Appendix to *Sci. Papers Phys. and Chem. Res. [Tokyo]* 20(431/454): [1]. 1933.) --The authors prepared a new "Kaen" which contains Na and K malates in place of NaCl, and is recommended for patients requiring the restriction of NaCl in their diets. In this paper some analytical data and the results of feeding experiments with rabbits are reported.

9291. Sinclair, Welton B., E. T. Bartholomew, and R. C. Ramey. (*U. California Citrus Exp. Sta., Riverside.*) Analysis of the organic acids of mango juice. *Plant Physiol.* 20(1): 3-18. 1945.--The total free acids in the juice of mature Valencia and navel oranges were calculated (1) from the titratable acidity, with phenolphthalein as indicator; (2) from the amt. of NaOH required to bring a known volume of orange juice to the equivalence point (pH 7.8 ± 0.1), when titrating potentiometrically; and (3) from the amt. of NaOH required to neutralize the liberated acetic acid formed when the organic acids and acid salts in the juice are precipitated by Pb acetate. The values detd. by these 3 methods are compared with the actual amt. of citric acid and combined citrates chemically detd. in the various samples. The acid constituents of orange juice, as detd. by titrating the juice directly with standard NaOH to phenolphthalein end point, were equivalent to the amts. detd. by the Pb acetate method. The total free acids detd. from the points of inflection on the titration curves were significantly lower than those reported both for the phenolphthalein titration and for the Pb acetate method. When juice samples were titrated with phenolphthalein as indicator, the end points ranged from pH 8.3 to 8.7. The potentiometric values have been taken to represent more accurately the total acidity. The type of malic acid in different juices examined varied only slightly, as compared with the changes in the citric acid content. With one exception, the samples studied had a malic acid content of from 0.1 to 0.7 mg. per ml. of juice, while the citric acid varied from 7.7 to 25.7 mg. per ml. Variation in acidity of the same variety is directly due chiefly to changes in the citric acid content. Generally, there is a definite relation between the free acid and combined acid balance and the pH of the juice. The amt. of combined acids remains nearly uniform during the season, the actual amt. in the fruit increasing. The conc. of free acids in the juice (mg. per ml.) decreases considerably during fruit development. This decrease in free acidity, with the corresponding increase in pH, was due chiefly to the decrease in conc. of free citric acid. Although the malic acid conc. in the juice (mg. per ml.) stayed nearly uniform during the season, the actual amt. in the fruit increased. The conc. of combined acids remained nearly uniform in the fruit, but the absolute amt. per fruit increased. The amts. of combined acids detd. from the alkalinity of the ash were in agreement with the values detd. from the difference between the total- and free-acid radicals. During ripening, the changes in pH of the juice were definitely related to changes in percentages of the total-acid radical in the free form. A similar relation was noted between pH and the % of free acid expressed on a fresh-wt. basis.—*W. B. Sinclair.*

7244. Sinclair, Welton B., and P. C. Ramey. (*U. California Citrus Exp. Sta., Riverside.*) Changes in the organic-acid content of Valencia oranges during development. *Bot. Gaz.* 105(2): 140-148. 1944.—The maximum amt. of free acid in Valencia orange fruits develops early in the season and changes very little from that time on. The conc. of free acids in the juice (mg. per ml.), however, lessens considerably during fruit development. This decrease in free acidity, with the corresponding increase in pH, was due chiefly to the decrease in conc. of free citric acid. Although the malic acid conc. in the juice (mg. per ml.) stayed nearly uniform during the season, the actual amt. in the fruit increased. The conc. of combined acids remained nearly uniform in the fruit, but the absolute amt. per fruit increased. The amts. of combined acids detd. from the alkalinity of the ash were in agreement with the values detd. from the difference between the total- and free-acid radicals. During ripening, the changes in pH of the juice were definitely related to changes in percentages of the total-acid radical in the free form. A similar relation was noted between pH and the % of free acid expressed on a fresh-wt. basis.—*W. B. Sinclair.*

4610. SINHA, S. (Agra Coll., Agra.) Investigation of certain chemical factors affecting the growth of fungi in mangoes. *Jour. Indian Bot. Soc.* 29(1): 197-209. 1950.--The growth of Aspergillus nidulans, Colletotrichum capsici and Acrotheciun penanc found on diseased mangoes is greatly affected by varying concen of malic acid, glucose, sucrose and levulose, which are found in mango fruits. There is also a certain degree of correspondence between the growth reactions of these fungi and their attacking power on mango fruits of different stages of maturity.
--A. C. Joshi.

16958. SOÓS, J. A szőlőn előforduló penészgombák hatása a szőlő és a must összetételére. [The effect of molds on the composition of grapes and must.] Kísérletügyi Közlemények 47: 32-39. 1948.-- Botrytis cinerea and Penicillium glaucum consumed tartaric and malic acid vigorously. The decrease of titratable acids was considerable if the media contained acids alone. If sugar was the sole source of C, an increase of the acid content was observed, as a result of additional acid formation. Mucor sp. consumed a little tartaric acid in presence of sugar but not in media free from sugar. The content of malic acid has also been reduced by Mucor in a slighter degree than by other molds. In sugar-containing media there was a noticeable increase of acidity. Aspergillus niger decreased the acidity only if the soln. did not contain sugar; it consumed tartaric acid also and produced acids from it, but not from sugar alone. All the 4 molds examined produced formic, oxalic, and citric acid from sugar.--D. Feher.

... SUBRAMANIAM, HOWARD BRATHWAITE, VE... SUBRAMANIAM, and THOMAS RETTIMON MAT... The mechanism of the degradation of fatty acids ... mould fungi. *Pt. 2. Jour. Chem. Soc. [London]* 19... (Sept.): 1957-1993. 1929.—*Aspergillus niger* was cultur...

† 93636. STERN, JOSEPH R., and R. W. O'BRIEN. (Sch. Med., Western Reserve Univ., Cleveland, Ohio, USA.) Oxidation of D- and L-(+)-malic acids by wild-type and mutant strains of Escherichia coli and by Aerobacter aerogenes. *J. Bacteriol.* 87: 147-151. Illus. Feb.--A mutant str. in of E. coli (Hfr Cavalli 51) capable of growth on D-malate as sole C source was shown produce D-malic enzyme. This enzyme was absent in the wild-type strain which was unable to grow on D-malate. Growth of on D-malate also resulted in a greatly increased level of L-(+)-malic enzyme compared with its level in the wild-type strain ... citrate or L-malate. The D-malic and L-(+)-isopropylmalic enzymes both of which catalyze a NAD- and Mg^{++}-dependent oxidation of their respective substrates, were shown to be distinct by selective inhibition with oxalylacetic acid, a competitive inhibitor of both enzymes. Cell-free extracts of the mutant strain grown on acetate, DL-lactate, L-(+)-malate, or D-malate contained, in order of decreasing activity, D-malic, L-(+)-isopropylmalic, and L-malic enzymes. Growth of the mutant strain on D-malate was accompanied by both the D-malic and L-(+)-isopropylmalic enzymes, ... oxidation of the other two substrates. Under these conditions ... ratio of the D-malic to L-(+)-isopropylmalic enzyme activities was ... by D-malate but not by L-malate, whereas L-malate behaved as a D-malic enzyme inducer. Growth of A. aerogenes on D-malate, which caused induction of D-malic enzyme, resulted in ... small increase in the activity of L-(+)-isopropylmalic enzyme.

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[illegible] TACHIBANA, SEI, JUICHI SODE, and TOSHIKO HANAI. [illegible] Fac., Ritsumeikan Univ., Kyoto, Osaka, Jap.) Studies [illegible] fermentation. XIV. On the relationship between L-[illegible]ation and carbohydrate metabolism of cell-free extracts [illegible] (Clostridium commune). J. Biochem. (Tokyo) 45(12): 1139-[illegible] 1957.--The activity of malic dehydrogenase linked to [illegible] was detected in the presence of orthophosphate (Pi) or inosine [illegible] and $KHCO_3$. The reductive carboxylation of pyruvate [illegible] inhibited by Pi. 3-Phosphoglyceric acid was more active than [illegible] in the reductive carboxylation system. Glyceraldehyde-3-[illegible] (GAP) dehydrogenase activity was detected, and a coupling [illegible] of malic dehydrogenase with GAP dehydrogenase was [illegible] Aldolase activity was detected, and aldolase could be followed [illegible] reduction of malacetic acid coupled with GAP dehydrogenase. [illegible]-Phosphate dehydrogenase activity was observed; it was [illegible] by addition of L-malate and NAD. Neither malic enzyme [illegible] lactic dehydrogenase activities were observed. The following [illegible] are proposed to explain the process of L-malate fermentation [illegible] Summary. Glucose + $2CO_2$ + 4Pi → 2L-malate + 2PP and [illegible] + $2CO_2$ + 2IDP (GDP) + 2Pi → 2L-malate + 2ITP (GTP).--Authors.

5720. Tischer, Josef. (*Inst. für allgemeine und analytische Chemie der Landwirtschaftlichen Hochschule Tetschen-Liebwerd.*) Über die Inhaltsstoffe der Früchte von Rhus typhina L. IV. Das Vorkommen von Krystallen des primären Calciummalates in der Samenepidermis. *Biochem. Zeitschr.* 308(4/5): 225–229. 1 fig. 1941.—About 1.1 kg. of ground *R. typhina* fruit are placed in a 4 l. flask, the bottom of which is covered with a layer of sand 1 cm. in depth. The top of the flask is closed with a stopper which contains a short glass tube for continuously adding water at 60°-70°, and a second glass tube which reaches nearly to the bottom of the flask and through which the aqueous extract is withdrawn. About 17 l. extract are collected in one day, and 51 l. of extract obtained from 3 extractions are concd. in vacuo to 1500 ml. Prismatic and holohedral shaped crystals separate, which are recrystallized from water and melt at 82°. The crystals are shown to be primary Ca malate, $(C_4H_5O_5)_2Ca.6H_2O$, by detn. of the equivalent wt. by titration with $N/10$ NaOH, by detn. of the Ca content and by identification of the malic acid. To identify the malic acid, an aqueous soln. of the Ca salt is treated with Pb acetate, and the Pb malate precipitated by addition of alcohol. The Pb malate is suspended in water and decomposed by H_2S, the mixture filtered, the filtrate dried in vacuo, the residue dissolved in acetone, an equal vol. of $CHCl_3$ added and crystalline malic acid ($C_4H_6O_5$), m.p. 100°, obtained. Microscopic examination of the fruit shows that prismatic crystals of primary Ca malate are present in the epidermis covering the seed. The crystals cover about 1/3 of the surface of the seed and constitute about 1.7% of the dry wt. of the seed.—*A. B. McCoord.*

[illegible]—Authors.

24121. TADA, SEIZI. Metabolism of organic acids by bacteria. I. II. *Jour. Agric. Chem. Soc. Japan* (*Nippon Nôgeikagaku Kaisi*) 16: 663-666. 1940.—I. *Bacterium* succinicum Selaguti et Tada was cultured on phosphate buffer soln. containing Na citrate at 37° for 72 hrs. The product was acidified with H_2SO_4 and then extracted with ether. Tricarballylic acid m. 161° and aconitic acid m. 156-157° were isolated from the ext. Succinic, *l*-malic, acetic and formic acids were also found in the product. Succinic and acetic acids were mainly produced. When tricarballylic acid was added to the bacteria suspension, no change was observed. Succinic and tricarballylic acids were produced from aconitic acid by the bacteria. When *l*-malic acid was added to the bacteria suspension at 37° for 120 hrs., succinic ac[illegible] and acetaldehyde were found. When fumaric acid was ad[illegible] succinic, malic and acetic acids were isolated. Succ[illegible] was not changed by the bacteria. Citric acid may be converted into succinic or acetic acid through aconitic acid.—II. Citric acid was decomposed by *Bacterium* succinicum, *Escherichia coli*, *B. communior*, *Aerobacter aerogenes*, *A. acetoicum*, *A. cloacae* and *A. lemans*. The R. Q. was established by Warburg's method. Aconitic acid was thought to be the center of metabolism of C_6-tricarboxylic acid.—*Y. Kihara* (*in Chem. Absts.*).

11194. TRAGER, WILLIAM. (Rockefeller Inst. Med. Res., N. Y. C.) Studies on the extracellular cultivation of an intracellular parasite (avian malaria). II. The effects of malate and of coenzyme A concentrates. Jour. Exptl. Med. 96(5): 465-476. Illus. 1952.--The extracellular survival and development in vitro of the erythrocytic stages of *Plasmodium lophurae* were favored by the addition to the culture medium of L-malic acid and concentrates rich in coenzyme A. In a concd. extract of duck erythrocytes supplemented with these 2 substances in addition to adenosinetriphosphate, Na pyruvate, and certain other materials of like nature, only 5-10% of the extracellular parasites had become abnormal after 3 days of cultivation at 39-40°C.--William Trager.

7539. TAVERNIER, JEAN, and PIERRE JACQUIN. Sur la présence de l'acide citrique dans la poire. Teneur comparative des moûts de poires en acides citrique et malique. [The presence of citric acid in pears. Comparative amounts of citric and malic acids in pear musts.] Compt. Rend. Acad. Sci. [Paris] 228(17): 1393-1394. 1949.--Qualitative determinations in several varieties of pears and in the musts from them were made for citric and malic acids. Dessert pears and a few perry pears contain a citric acid level similar to apples: 1.5-13% of the total acidity, but certain perry varieties have more: 40-60%. This high amount explains the tartness of the perries when used in cider. Certain perries contain up to 8 g./l. of citric acid, which is of interest in human nutrition.--R. J. Gautheret.

11060. TURNER, J. F. The metabolism of the apple during storage. Australian Jour. Sci. Res. Ser. B. Biol. Sci. 2(2): 138-153. Illus. 1949.--A survey was made of changes in amts. of certain metabolites and possible respiratory intermediates in the flesh of Australian Granny Smith apples during storage at 0°C. Respiratory activity shows 2 peaks; carbohydrates form the predominant substrate for respiration. Evidence indicates that a carbonyl compound of low mol. wt. may be an intermediate in carbohydrate metabolism. Fluctuations in total organic acids, malic acid, and citric acid suggest that the tricarboxylic acid cycle of Krebs may operate in carbohydrate oxidation in the apple. Ascorbic acid, which decreases during storage, and oxalic acid, which remains constant, do not fluctuate significantly with the respiration rate. Total N remains approx. constant during storage but there is an appreciable synthesis of protein. This synthesis appears to be related to the large reserves of available carbohydrate and is dependent on the level of respiratory activity. --Auth. summ.

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...THOMAS, F. P. (U. California Citrus Prod. Fac., Riverside), ...EETAE, PHILIP F. ...water especially on leaf of [illegible] of ...of sulphur-resistant and sulphur-susceptible varieties of apple (Pyrus ...L.) and crabapples (Malus [illegible] L.) ... Proc. Amer. Soc. Hort. Sci. Fac. 1956; 111-123. Illus. In [illegible]--In leaves of ...and resistant varieties of apples (susceptibility) was found to ...correlated with high pH and low buffer capacity in expressed leaf-... fluids, which results are [illegible] theory. These correlations sug-...gest that accumulation of [illegible] prior to protein injury. In apple leaves ...specially appears to play a less significant role than in goose-... berry leaves. The principal buffers are malic, citric, and possibly ...quinic acids and their salts in apple leaves, and citric and malic ...acids and their salts in gooseberry leaves. Buffer capacity declines ...as pH increases in apple leaves with age.--Auth. summ.

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753. ULLRICH, HERMANN. Zur Physiologie der organischen Säuren in grünen Pflanzen. II. Tagesschwankungen und anderweitig bedingte Veränderungen des Gehalts an verschiedenen organischen Säuren in einigen grünen Pflanzen. [The physiology of organic acids in green plants. II. Daily oscillations and otherwise induced alterations in content of various organic acids.] *Zeitschr. Wiss. Biol. Abt. B, Planta* 1(4): 565-568. 1926.—Rapidly growing leaves of *Anemone nemorosa*, *Rubus idaeus*, *Begonia semperflorens*, *Lactuca sativa* and *L. virosa* were employed, determinations on both leaves and petioles being made in the last two. In *L. sativa*, oxalic acid was practically constant in amount in leaves and petioles in morning and evening; lactic acid was almost constant in petioles, but the amount in the blades at 6:10 P.M. was almost 3 times as great as at 7:15 A.M. The amount of succinic acid found at evening was in leaf blades ½, in petioles ¼ that present in these parts in the morning. Malic acid in leaf blades was twice as great in amount in the morning as at evening, and the amount in the petioles was greater in the morning. The sum of malic plus succinic was constant in the petioles, very nearly constant in the blades. The *p*H of the blades was constant, petioles higher in the morning. The reduction of acid in darkness may indicate a resynthesis of therefrom. (For Part I, see Ruhland, W. Wetzel, B.A. 2(1/2): Entry 554.)--*J. S. Caldwell*

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1 10001. WATANABE, SHIRO, and TAKEYOSHI OSAWA. (Fordstoff Fabr., Asahi Chem. Ind. Co., Limited, Asahi, Jap.) Studies on the production of L-malic acid by bacteria. I. Actions of detergents on the production of L-malic acid. HIFUMI NOGEI KAGAKU KAISHI (J. AGR CHEM. SOC. JAP.) 40(9): 319-324. Illus. 1966. [Engl. summ.]--The procedure converting fumaric acid to L-malic acid by Brevibacterium ammoniagenes was studied to establish an advantageous method for the production of L-malic acid. In spite of possessing fumarase in the bacterial cell, the productivity of L-malic acid from fumaric acid was weak. The appropriate addition of detergents such as cetylpyridinium-chloride (C.P.C.) into the reaction mixture or the growing culture markedly accelerated the enzymatic conversion. Cationic, anionic and amphotylic surfactants were effective for L-malic acid production. The effects of addition of detergents for L-malic acid production by growing cells were studied. Brevibacterium sp., Corynebacterium sp., Bacillus sp., and Proteus species and L-glutamic acid-producing bacteria convert fumaric acid to L-malic acid quantitatively on C.P.C addition to the growing culture. When sodium fumarate was used as substrate, the molar yield of L-malic was lower than when calcium fumarate was used. Fumaric acid added a maximum of 10 g/100 ml concentration to the medium could be quantitatively converted to L-malic acid. The effective detergents for L-malic acid formation promoted the cell permeability of fumarate and completely inhibited the respiration of bacteria; as a result, they accumulated a large amount of L-malic acid.--Authors.

1 10011. WEBB, A. DINSMOOR, RICHARD E. KETHER, and LINDA PAGGIORA. (Univ. Calif., Davis, Calif., USA.) Identification of ethyl acid tartrate and one isomer of ethyl acid malate in California flor cherry. J AGR FOOD CHEM. 15(2): 334-339. Illus. 1967.--Ethyl acid tartrate and the ethyl acid malate isomer having the free carboxylic acid group adjacent to the carbinol group have been isolated from a California Palomino flor sherry wine by product elution from an ion exchange column followed by gas chromatographic purification of the methylated (diazomethane) acid esters. Identification was accomplished by comparison of the infrared and mass spectra of the methylated wine esters with synthetic compounds of known structure. The presence of a single isomer of ethyl acid malate in the wine suggests that it is produced enzymatically during the primary fermentation. Hydrogen ion-catalyzed reaction of ethanol with malic acid yields a mixture of 2 parts of the isomer having the free carboxylic acid group adjacent to the carbinol group and one part of the other isomer.--Authors.

24762. ULRICH, R., and O. THALER. (Lab. Physiol. Végétale Fac. Sci. Paris.) Variations quantitatives et qualitatives de quelques constituants glucidiques, acides et azotés de la poire Williams, au cours de son développement. [Qualitative and quantitative variations of sugars, organic acids, and amino acids content during the development of the Williams pear.] Jour. Agric. Trop. et Bot. Appliquée 4(1/2): 12-50. 1957.--Studies on the development of the Williams pear show that sugars, organic acids and amino acid content vary from year to year, even if growing conditions are similar. During the period of maximum growth a pear gains 2 grams of water, 8 mg of mineral substances, 150 mg of soluble sugars, 0.06 meq of organic acids, and 25 mg of pectic substances per day. The sugars accumulating in the ripening pear are saccharose, glucose, xylose and principally fructose; saccharose con-

centration reaches a peak at about the time of ripening. Malic, ... citro-malic, quinic and chlorogenic acids accumulate in the fruit ... growth and are metabolized during maturation. Alanine, proline, ... acid, serine, valine, leucine, tyrosine, phenylalanine and ... acid are present either in a free state or in proteic combinations. ... is a significant increase in the concentration of proline during the ... of maturation. There is a decrease in the concentrations of gluta... acid, aspartic acid and asparagine toward the end of the growing ... and during the maturation of the fruit. The concentration of tryp... decreases from May to July. These data, added to previously ... data regarding the respiration, formation of pectic substances and ... tion of volatile products, allow the formation of a biochemistric ... logical picture of the Williams pear during growth and matur... mechanisms involved are still unknown.--Jacques Lipetz.

25123. WEGENER, JOHN B. (U. S. Dept. Agric., Washington, D.C.) Relationship of naturally occurring tartaric acid to certain physical constants of concentrated Concord grape juice. Food Technol. 13(1): 4-7. 1959.--Regression curves relating soluble solids, as sucrose, determined refractometrically to per cent by weight of tartaric and malic acid; and determined by the Brix hydrometer, to per cent by weight of tartaric acid were developed. When soluble solids of tartaric acid solution are evaluated by refractometer, a positive correction is required. A negative correction must be applied when soluble solids obtained by Brix hydrometer. Amount of correction increases with increasing tartaric acid concentration. When corrections are applied, both methods of evaluating total soluble solids of synthetic mixtures of tartaric acid and sucrose yield values agreeing closely with those actually present. These corrections may be applied to concentrated Concord grape juice.--Auth. abst.

2413. WEHNE, WILHELMINE. (Inst. Allg. Bot., Friedrich-Schiller-[illegible], Jena, East Ger.) Der Einfluss der Temperatur auf die Bildung von Zucker, Zitronensäure und Weinsäure in Weintrauben. [The influence of temperature on the formation of sugar, malic acid and tartaric acid in grapes.] *Flora (Jena)* 146(3): 211-231. illus. 1958. [Germ. 1958].—With increasing average temperature the content of sugar increases; the amount of acid which can be titrated decreases. The amount of malic acid in ripe grapes depends on the temperature. Increased precipitation is unimportant. High average temperatures [illegible] each member of sunny days in May, June and July cause a quick decrease of the malic acid level. The measurements of tartaric acid in grapes show a much lower range of variability compared to the malic acid. The variations in the total content of acid that can be titrated are determined by the variation of the malic acid content.
--Auth. sum. transl.

2414. WEIDEL, K., and W. [illegible]. Zur Frage der Zuckerbildung in Crassulaceen. *Z. physiol. Chem. Hoppe-Seyler's Ann. Biochem.* 311: 261-271. 1958. [Germ.] The formation of malic acid in CO2 atmosphere probably takes place through pyruvic acid which as accumulation of aldehyde and hence a retardation of carboxylase activity occur, thus interfering with the normal course of sugar breakdown. (See preceding abstract.)—*O. P. Miller.*

2415. [illegible]. Researches on the carbon/nitrogen ratio in plants. [Mimeographed.] 29 p. [London: Science Museum Library Bibl. Ser.] [No date, but obviously after 1951.]

1395. WOLF, [illegible]. Beobachtungen über Veränderungen des Gehaltes an organischen Säuren im Blutungssaft von Birke (Betula alba) und Ahorn (Acer pseudoplatanus). *Planta* 23(4): 721-724. 1 fig. 1935.—The pH values ranged from 5.1 to 5.4 in the birch and from 5.8 to 6.35 in the maple. The N side of the tree has more acids than the S. Most of the acid is malic acid, a lesser amount citric acid. Both acids—and total acids—decreased sharply at first and remained fairly constant during the latter period. The observations were made during the time between April 2 and Apr. 11.—*B. R. Nebel.*

2416. Wolff, [illegible]. Beiträge zur Kenntnis [illegible] Crassulaceen-Arten. *Schweiz. Wschr. f. Chem. u. Pharm.* 15(5): [illegible]. 19 fig. 1951. [Germ.] Studies were done on *Bryophyllum calycinum*, *B. crenatum*, *B. proliferum*, and *Kalanchoë glaucescens*. The relationships between metabolism of acid and nitrogenous compounds are observed. The chief acid formed at night is malic acid and the total acid increased with the age of the leaves, the older ones showing a characteristic pattern due to the concentration of acid malates. The maximum concentration of acid takes place around 20°, while at a lower temp. the formation of acid salts increases. By the exclusion of air, acid production is either entirely stopped or much inhibited, and narcotics have a similar effect. The metabolism of acids in the Crassulaceae is in many respects similar to that of glucose in animals.—*O. F. [illegible]*

RESPIRATION

20771. Wood, J. G., D. H. Cruickshank, and E. H. [illegible]. (*U. Adelaide, Australia.*) The metabolism of [illegible] leaves. 1. Presentation of data; the nature of respiration rate-time curves in air and in nitrogen and the relation to carbohydrates. 2. Changes in amounts of total and chloroplast proteins, chlorophyll, ascorbic acids and soluble nitrogen compounds. 3. Changes in malic acid and citric acid contents and inter-relations of these with soluble nitrogen compounds. *Australian Jour. Exp. Biol. and Med. Sci.* 24(1): 37-53. 12 fig. 1946.—Details are given of 8 expts. in which leaves of Sudan Grass (*Andropogon sudanensis*) and Kikuyu Grass (*Pennisetum clandestinum*) were placed under starvation conditions both in air and in N_2. Observations which are essentially new include the following: During starvation in air chloroplast protein is broken down into soluble products. In Sudan Grass chloroplast-protein breaks down more rapidly than cytoplasmic protein, but in Kikuyu both chloroplast and cytoplasmic proteins break down at approx. equal rates. Decrease in amt. of protein with time is approx. linear until a point is reached, coincident with cessation of yellowing, when there is little further decrease in protein. Decrease in amounts of chlorophyll, ascorbic acid and dehydroascorbic acid is associated with decrease in chloroplast protein. Cessation of protein hydroly is in the leaves is associated with disintegration of the chloroplast structure. In air onset of protein breakdown is determined by the initial sucrose content; and residual amino acids, glutamine, asparagine and ammonia successively attain max. contents, but their formation commences with commencement of protein breakdown. The max. asparagine content coincides with cessation of protein loss. In N_2, amt. of protein degradation is very small compared with that in air and amino acids only, but not amides and ammonia, accumulate in the leaves. On transferring the leaves to air proteins decrease in amt. and production of amides and ammonia takes place. In air respiration rate initially decreases with falling sucrose content, but this is followed by a climacteric rise which occurs between the times of max. residual amino-acid content and max. asparagine content. The onset of the climacteric appears to be determined by the initial carbohydrate content and its form by the sucrose and amino acid contents. In N_2 no climacteric rise in respiration rate occurs. The sucrose content decreases more rapidly than in air and the form of the respiration rate/time curve is similar to that for sucrose content curve. Malic and citric acid contents exhibit little change in N_2. In air citric acid increases during early stages of starvation but later reaches a steady value or decrease in amt. Increase in citric acid is associated with decrease in sucrose content and increase in amino and asparagine content. In air malic acid content at first remains approx. constant but later increases markedly in amt. Increase in malic acid content is accompanied with marked increase in sucrose content. Later still, malic acid decreases in amt. and [illegible]

2417. Wolff, [illegible]. Beiträge zur Kenntnis [illegible] Crassulaceen-Arten. *Schweiz. Wschr. f. Chem. u. Pharm.* 15(5): [illegible]. 19 fig. 1951. [Germ.] Studies were done on *Bryophyllum calycinum*, *B. crenatum*, *B. proliferum*, and *Kalanchoë glaucescens*. The relationships between metabolism of acid and nitrogenous compounds are observed. The chief acid formed at night is malic acid and the total acid increased with the age of the leaves, the older ones showing a characteristic pattern due to the concentration of acid malates. The maximum concentration of acid takes place around 20°, while at a lower temp. the formation of acid salts increases. By the exclusion of air, acid production is either entirely stopped or much inhibited, and narcotics have a similar effect. The metabolism of acids in the Crassulaceae is in many respects similar to that of glucose in animals.—*O. F. [illegible]*

17030. WIKÉN, TORSTEN, and NORBERT PFENNIG. (Inst. Landwirtsch. Bakt. u. Gärungsbiologie, Eidg. Techn. Hochschule, Zürich.) Untersuchungen über die Physiologie der Weinhefen. VII. Mitteilung. Über den Einfluss üblicher Puffersysteme organischer Säuren auf die aerobe und anaerobe Vergärung von Glucose durch die Weinhefe "Fendant" aus jungen und alten Kulturen. [Investigations on the physiology of wine yeasts. VII. The influence of the usual buffer systems of organic acids on aerobic and anaerobic fermentation of glucose by the wine yeast "Fendant" from young and old cultures.] Antonie van Leeuwenhoek, Jour. Microbiol. and Serol. 23(2): 113-149. 1957.--Anaerobic fermentation by a yeast suspension was greater in 0.01-0.12 M solutions of [illegible] acid-succinate (pH 4.9) than in distilled water. Under anaerobic conditions this stimulation of fermentation occurs only at lower concentrations of the buffer (0.01 M). Aerobic yeast suspensions in 0.1 M [illegible] and anaerobic ones in 0.08 M are inhibited in the earlier stage and stimulated in the later stages when compared with distilled water. At higher concentrations the fermentative capacity of young cultures is strongly inhibited. Fumaric acid-fumarate, DL-malic acid acetate, citric acid-citrate and D-tartaric acid-tartrate at low concentrations stimulate the fermentation of young cultures, whereas acetic acid-acetate inhibits the fermentation even at 0.05 M. At higher concentrations all buffers examined inhibit fermentation. The effect of succinic acid-succinate on young cultures is specific as far as the difference in inhibiting power under anaerobic and aerobic conditions is concerned. Under anaerobic conditions a similar although minimal effect is produced in D-tartaric acid-tartrate. In fumaric acid- fumarate and malic acid-malate the effect is produced only at concentrations beyond the physiological range. In citric acid-citrate and acetic acid-acetate solutions no effect is produced. Thus succinate is not formed in the latter solutions. The inhibition under anaerobic conditions at pH 4.9 by succinic acid-succinate is reversed by molecular O_2 added previous to addition of sugar, the rate of fermentation increasing with increasing supply of O_2. Succinic acid-succinate determines the rate of alcoholic fermentation by interacting with molecular O_2 and one or more components of the zymase system. The zymase system which is "masked" in resting young yeast material in presence of succinic acid-succinate under anaerobic conditions is "unmasked" by supply of molecular O_2. Cells harvested from old cultures are insensitive under the conditions applied.
--From auth. summ.

2418. WEHNE, WILHELMINE L. Versuche über die [illegible]ption bei Eupagurus bernhardus (L.). *Tijdschr. Nederland. Dierkund. Vereen.* 1(3): 102-112. 1929.—Reception of animals to saccharine, quinine hydrochloride, phenol, coumarin, malic acid, and artificial musk of different concentrations made up in sea water was observed. Animals just trained on meat soaked in the solution to be [illegible]. Solutions added in measured amounts from a pipette held between the antennae. Animals reacted to material odorous to man. Reaction threshold is much lower in previously trained than in untrained animals.—*B. R. Weimer.*

III. MALIC ACID ITEMS NOT INCLUDED IN FDA REVIEW

1967

BARNETT, D., COHEN, R. D., TASSOPOULOS, T., TURTLE, J. R., DIMITRIADOU, A. and FRASER, T. R. A method for estimation of Krebs cycle and related intermediates in animal tissues by gas chromatography. *Anal. Biochem.*, 1968, 26, 68–84. [Dept. Med. Biochem., Postgrad. Med. Sch., London, W.12.]

... pyruvic, β-hydroxybutyrate, citric, α-keto...aric, succinic, fumaric and malic acids were extracted from tissues, methylated, purified and separated by gas chromatography. Internal standards labelled with ^{14}C were used to correct for losses. The method was applied to rat tissues.—A. H.

5417

... S. and BISWAS, D. K. Urinary excretion of pyruvic acid, α-keloglutaric acid, and oxaloacetic acid in scurvy. *J. Biol. Chem.*, 1959, 234, 3094–3096. [Dept. Physiol., Rajshaner Med. Coll., India.]

In previous work see Abst. 5111, Vol. 28. ... guineapigs weighing from 250 to 300 g. were ... 5 or 6 days on green grass, soaked gram and ... thalogenic diet (Abst. 2319, Vol. 15). Thon ...

Vol. 30, No. 3

2101 BRITTEN, J. S. Enzymic estimation of D-... and other D-2-hydroxy acids. *Anal. Biochem.*, ... 24, 330–336. [Dept. Physiol., Coll. Physicians ... ons, Columbia Univ., New York, N.Y. 10032.]

D-2-Hydroxyacid oxidoreductase was partly purified from rabbit kidney and can be used to estimate malic or lactic acids.

1969

365 CUMMINGS, G. A. and TEEL, M. R. Effect of nitrogen, potassium, and plant age on certain nitrogenous constituents and malate content of orchardgrass (*Dactylis glomerata* L.). *Agronom. J.*, 1965, 57, 127–129. [Purdue Univ., Agric. Exp. Stat., Lafayette, Ind.]

Cocksfoot (*Dactylis glomerata*) was fertilised with 30, 200 or 400 lb N per acre and with each no K or 166 or 332 lb per acre was given. Plots were cut after 4 or 6 weeks. Malate, true protein, free amino N and N.P.N in herbage cut above 4 in. were positively correlated with the amount of N given in plants of either age. There was less true protein in the older plants, but similar total N, less malate. In the older grass K fertiliser increased K content and true protein and reduced free amino N and N.P.N. N.P.N increased and true protein and malate decreased with ...—T. D. B.

1966

369 GAWĘDA, H. and RALSKA, M. Rola ziół w ... zwierząt w składniki mineralne i ... ty śladowe. [Role of herbs in supplying minerals and trace elements to animals.] *Roczn. Nauk rol. [B]*,

AND CONGRESS REPORTS Vol. 3, No.

Algiers, March 1962. FILLIOU, M., SABATINI, R., ... ROWSKI, J. and GRANDJEAN, J. P. (971), malic acid ... arginine in the treatment of protein malnutrition in ... infant.—D. Duncan.

2958

GOODBAN, A. E. and STARK, J. B. Rapid method for determination of malic acid. *Anal. Chem.*, 1957, 29, 283–287. [W. Utilization Res. Branch, Agric. Res. Serv., U.S. Dept. Agric., Albany 10, Calif.]

Malic acid is separated on columns of the resins Amberlite IRA-400 and Dowex 50 and estimated colorimetrically in the eluate by its reaction with 2 : 7-naphthalenediol and H_2SO_4. Interference by other acids likely to occur along with malic acid is discussed.—H. G. Bray.

2148 LEHMANN, G. and MARTINOD, P. Trennung organischer Säuren auf Cellulose-Dünnschichtplatten. [Separation of organic acids on thin layers of cellulose.] *Ztschr. Lebensmittel-Untersuch. -Forsch.*, 1966, 130, 269–273. [Inst. Org. Chem., Univ. Saarland, Saarbrücken.] German.

1967

The separation of tartaric, ascorbic, citric, malic, succinic and lactic acids on thin layers of cellulose with butanol, formic acid and water (8 : 3 : 10) or pentanol, formic acid and water (20 : 20 : 1) as solvent is described. The 2 solvents are also suitable for two-dimensional separations.

101 LI, K. C. and WOODROOF, J. G. Gas chromatographic resolution of nonvolatile organic acids in peaches. *J. Agric. Food Chem.*, 1968, 16, 534–535. [Georgia Exp. Stat., Experiment, Ga. 30212.]

Chromatography of methyl esters showed that the main acids of peach were malic and citric; succinic acid was tentatively identified.

1969

...RGENSSON, J. Citric acid metabolism in the kidneys after administration of malic acid. *Skand. Arch. Physiol.*, 1939, 83, 113–120. [Physiol. Inst., Univ. Lund, Sweden.]

...rfusion experiments with isolated ...ney the addition of *l*-malic or malonic acid ... the perfusion fluid caused a decrease in the amount of citric acid converted in the perfusing blood, and an increase in the citric acid excreted from the urine. There was no evidence of any formation of citric acid by the kidney. Furthermore, the injection of *l*-malic acid into rabbits and rats was followed by a rise in the citric acid content of the serum and a diminution in the normal difference between the citric acid content of the arterial blood and that of the renal vein. These results support the author's thesis that citric acid is eliminated mainly by the kidneys, chiefly by decomposition and to a small degree by excretion. Malic acid presumably inhibits the breakdown of the acid in the kidney. There is no corroboration of Krebs' "citric acid cycle" theory, which postulates a direct conversion of succinic, fumaric, *l*-malic or oxalacetic acid into citric acid in the kidney.—M. A. B. Fixsen.

...MANN, ... chronique sur les principaux acides du cycle tricarboxyliques et métabolites voisins. [Effect of chronic renal insufficiency on the principal acids of the tricarboxylic acid cycle and related metabolites.] *Clin. chim. Acta*, 1965, 12, 304–310. [Lab. Biochim., Clin. chirurg. Salpêtrière, Paris 13.] French; English summary.

In 40 adult patients with chronic renal insufficiency pyruvic and citric acids in blood were in normal concentrations, lactic acid was significantly low and α-ketoglutaric acid and, especially, malic acid were high. Output in urine of citric and α-ketoglutaric acids, but not of malic acid, was greatly diminished. The changes in blood values could not be related to modifications of the metabolic or excretory functions of the kidney, nor could they be explained by variations in acid base equilibrium or the degree of reduction of nicotinamide adenine dinucleotide. Enzyme inhibitors, especially those acting on malic dehydrogenase, seemed to play an essential part in the genesis of the changes.

...ION OF FOODSTUFFS

263

PROKOSHEV, S. M. and PETROCHENKO, E. ... Soderzhanie i prevrashchenie limonnoi ... yablochnoi kislot v klubnyakh kartofel'y. [Contents of and changes in contents of citric and malic acids in potato tubers.] *Dok. Akad. Nauk S.S.S.R.*, 1950, 72, 983–9... [Inst. Biokhim. Baku., Akad. Nauk. S.S.S.R.

Tubers of 4 types of potatoes, after 6 to 7 months storage, were analysed for their citric and malic acid contents. The tubers were ground and extracted with ether. Citric acid was estimated by the pentabromoacetone method, and malic acid by the dinitrophenylhydrazine method of Puche *et al.* (Title, p. 466, Vol. 4). The average amounts of citric and malic acids were 0·2 and 0·112 per cent., respectively, giving a citric acid : malic acid ratio of 1·95 : 1, which is at variance with a ratio of 20 : 1 given by Garland and Nelson (*Amer. Potato J.*, 1940, 17, 328).

In order to investigate a possible connection between wound biosynthesis of ascorbic acid and changes in citric and malic acid contents, cylindrical pieces of tubers were cut out, washed with water, dried on filter paper and stored in one of desiccators. One desiccator, (*a*), contained 15 per cent. NaOH to absorb any CO_2 formed, the other (*b*) contained Na_2CO_3 and H_2SO_4 to give a 5 per cent. atmosphere of CO_2. For pieces kept in (*a*) the sum of citric and malic acids remained unchanged, but about half of the citric acid was converted into malic acid, so that the original ratio was reversed. For pieces kept in (*b*), however, the sum of citric and malic acids decreased by about 14 per cent., the decrease being entirely in citric acid. Other experiments in which neutralised pyruvic acid was infused into tubers showed that pyruvate reduces to a very small extent the inhibiting action of CO_2 on the biosynthesis of ascorbic acid.—W. Hughes.

...ON OF FOODSTUFFS

Legumes

1834

MORRISON, R. I. and DEKOCK, P. C. Glyceric ... in broad bean (*Vicia faba* L.). *Nature*, 1964, 204, Suppl. No. 11, 819. [Macaulay Soil Res., Craigiebuckler, Aberdeen.]

Leaves of broad bean grown in a field ... glyceric 26·7, citric 2·4 and malic acid 6·6 ... per kg. fresh weight; corresponding ... stems were 33·4, 15·6 and 13·7. Values ... given for beans grown in water culture or ... A. Hep...

...30 R. J., ... d Burki ... Reg. R ... range and ... and flesh ... ...e 37·1 t... 12·3, prot... 16 to 1·46 ...(17) 0·59 to ...al based on ...were 4·62

...52, 61, 31... rd.]

...TE, K. A ...de hacne ...olorimét...

1559

...ISCHKÉ, E. Méthode de dosage colorimetrique de l'acide malique dans les vins et les moûts. [Colorimetric estimation of malic acid in wines and musts.] *Mitt. Geb. Lebensmittel. Hyg.*, 1952, 43, 50–57. [Lab. de l'Etat, Luxembourg.] German summary.

...at

...Fil...

Legumes

PUCHER, G. W., VICKERY, H. B. and WAKEMAN, A. J. Determination of malic acid in plant tissue. Simultaneous determination of citric and malic acids. *Indust. Eng. Chem. (Analytical Ed.)*, 1934, 6, 288–291. [Connecticut Agric. Exp. Stat., New Haven, Conn.]

...[Agri...

...ews. S... cage. 19, Veter...

...ORTH. I... Dairie...

RASMUSSEN, H. Separation and detection of carboxylic acids by thin-layer chromatography. *J. Chromatography*, 1967, 26, 512–514. [Inst. Biol. Chem., Univ. Copenhagen.]

Chromatography on cellulose with chloroform, *tert*-amyl alcohol, formic acid and water (136 : 24 : 27 : 83) as solvent was used to separate fumaric, succinic, malic and citric acids. Plates were best dried in daylight and examined in ultraviolet light. The indicator, 2,7'-dichlorofluorescein, was dissolved in the organic phase of the solvent at a concentration of about 4 mg%.—A. H.

80

REIFER, I. Mikrometoda oznaczania kwasu jabłkowego. [A micromethod for estimating malic acid.] *Acta biochim. polon.*, 1955, 2, 367–381. [Zakl. Biochem. SGGW, Warsaw.] Russian and English summaries.

The method is based on the oxidation of malic acid to dibromoacetaldehyde, which reacts with dinitrophenylhydrazine to give a blue complex in alkaline alcoholic solution. The blue colour is measured in a photocolorimeter. Amounts from 0·5 to 16 μg. malic acid can be estimated. (From summary.)—E. M. Hume.

2711

ENTSCHLER, H. Die biochemische Bestimmung der Äpfelsäure. [Biochemical estimation of malic acid.] *Mitt. Geb. Lebensmittel. Hyg.*, 1918, 39, 30–36.

5867 RUMSEY, T. S., NOLLER, C. H., RHYKERD, C. L. and BURNS, J. C. Measurement of certain metabolic organic acids in forage, silage, and ruminal fluid by gas-liquid chromatography. *J. Dairy Sci.*, 1967, 50, 214–219. [Dept. Animal Sci., Purdue Univ., Lafayette, Ind.]

Gas-liquid chromatography was suitable for estimating lactic, oxalic, malonic, fumaric, succinic, malic, α-ketoglutaric and citric acids. Aqueous extracts of ground and dried forage, extracted at 55°C, were lyophilised and the organic acids contained in the residue were esterified with methanol and HCl. Esters of the acids were then chromatographed. Aqueous extracts of silage and protein-free filtrates of ruminal fluid, prepared by acetone-ethanol precipitation, were analysed. Recoveries from added amounts of all acids were near 100%. Two groups of forage samples, containing both freeze- and oven-dried samples, had similar amounts of organic acids and the differences due to method of drying were analogous for both groups. Lactic acid measured in silage samples was comparable to that measured in the same samples by the $FeCl_3$ and *p*-hydroxydiphenyl methods, but clearing peaks were encountered when some ruminal fluid samples were chromatographed. The interference may have been due to incomplete protein precipitation and was greatest with samples from an animal on a high-grain ration, in contrast to samples from animals receiving a maize silage ration.

4100 RUMSEY, T. S. and NOLLER, C. H. A study of the quantitive measurement of certain metabolic acids by gas-liquid chromatography. *J. Chromatography*, 1966, 24, 325–334. [Dept. Animal Sci., Purdue Univ., Lafayette, Ind.]

Methyl esters of lactic, oxalic, malonic, fumaric, succinic, malic, α-ketoglutaric and citric acids were separated by chromatography on Chromosorb W containing 15% diethylene glycol succinate. Some esters did not give a linear response with increasing concentrations. Lyophilisation was suitable for dehydrating aqueous samples.

4101 RUMSEY, T. S. Quantitative measurement of metabolic acids in forage, silage, and ruminal fluid by gas-liquid chromatography. *Dissertation Abstr.* (*B*), 1966, 27, 86-B.

Methyl esters of lactic, oxalic, malonic, fumaric and succinic acids were separated isothermally at 140°C on a 9-ft column containing 15% diethylene glycol succinate on Chromosorb W; malic and α-ketoglutaric acids were separated at 200°. Methyl citrate was separated on a 5-ft column at 200°.

A. H.

1429

SUOMALAINEN, H. and ARHIMO, E. Oxidative bromination in the determination of malic acid and aspartic acid. Micromethod for determination of beta-alanine. *Anal. Chem.*, 1947, 19, 207–209. [Dept. Biochem., Alcohol Res. Lab., Helsingfors.]

It is shown that the dinitrophenylhydrazine derivative obtained in the method of Pucher, Vickery and Wakeman (Title, page 466, Vol. 4) for the estimation of malic acid is glyoxal-2 : 4-dinitrophenylosazone. Since this product can be obtained from dibromo-acetaldehyde but not from bromal it would appear that this acetaldehyde is the probable intermediate in the reaction. It is shown that β-alanine reacts in a manner analogous to malic acid and that the method can be employed for its micro-estimation.—W. Godden.

#50

FOOD AND DRUG Research LABORATORIES, INC.

60 Evergreen Place
East Orange, New Jersey 07018
(201) 677-9500

6.2.3.1.93

ACCESSION NO. 391

MALIC ACID

CAS REG. NO. 000097-67-6

Submitted to:

GRAS Review Branch (BF - 335)
Bureau of Foods
Food and Drug Administration
200 C Street, S. W.
Washington D. C., 20204

Att: Mr. Alan Spiher
Project Manager

Prepared by:

Harriet Dolin
Harriet Dolin
Senior Scientific Writer

Date: June 29, 1973

Laboratory No. 1216

Howard Feinman
Howard Feinman, Director
Biological Sciences

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MALIC ACID

Summary

Although only two references to malate salts were encountered, sodium malate (304) and manganese malate (28), the terms malic acid and malate are used synonymously throughout the literature and are so used in this monograph.

The acute toxicity of malic acid administered as a 0.25N solution by injection at the rate of 10 cc per 3 minutes into the Vena jugularis dextra of rabbits has been found to be 2,400 mg/kg (194). No LD_{50} values were accessible in the available literature.

Rabbits of approximately 2.85 kg body weight fed 70 mg/kg/day of cholesterol plus twice weekly intraperitoneal injections of about 100 mg/kg of malic acid for 5 months doubled their blood cholesterol over that of the control animals fed only 70 mg/kg/day of cholesterol. In an experiment where the feeding of cholesterol was ceased prior to the feeding of malic acid, the blood cholesterol returned to normal within 30 - 50 days and was accompanied by a reduction of total cholesterol and total lipids in the organs of the rabbits (225). Without the addition of cholesterol to the diet, malic acid did not increase the normal blood cholesterol level (33). Other evidence indicates that higher levels of malic acid, 1,000 mg/kg of rabbit body weight, lowered the cholesterol and total lipid content in the liver, adrenals and aorta in spite of an atherogenic diet of cholesterol 200 mg/kg (224). However, the initial stages of elastic fiber degeneration and an accumulation of acid mucopolysaccharides were revealed in the aortic sections of those rabbits

receiving both 70 mg/kg/day cholesterol and 300 mg of malic acid twice weekly. Athroscelerotic changes due to an accumulation of decomposition products and collagen in the aorta wall were also revealed in these rabbits. This degeneration plus general lipogenesis were more marked when malic acid and cholesterol were fed simultaneously than when cholesterol was administered alone. These aortic changes were similar to those found for citric and fumaric acids and, therefore, may be due to an interference by malic acid with the normal oxidative processes of the Krebs cycle (33).

Apparently superior survival rates than the controls and no toxic symptoms were encountered when Albino rats of the Charles River strain were fed malic acid. The study was conducted at 0.05%, 0.5%, and 5.0% of the diet for 104 weeks. Growth was significantly suppressed during the first year at the 5% dietary level. During this period, the male test rats of this group consumed considerably less food. The females of the group recovered their appetite after 26 weeks. During the second year there was little distinction between the test and control rats. The lower weights were reflected in some of the organs for rats on the 50,000 ppm malic acid diet level. Higher spleen weights were found for the male rats at the same feeding level. Other parameters studied were considered within the normal limits of variation and not malic acid related.*

Chronic dietary administration of malic acid at 500; 5,000;, and 50,000 ppm levels of dogs produced no differences in general appearance, body fluids tested, or gross pathology or histopathology "attributable to consumption of the compound." *

*Private communication from Allied Chemical Corporation

A conclusion that unknown metabolic pathways exist in the heart muscle resulted from studies on the infusion of malic acid in an artificial blood through in vivo hearts (470) and isolated rabbit auricles (501). The hearts developed myocardial insufficiency (470). However, the auricular beat amplitude decreased while its slowed rate remained stable as the concentration of malic acid was depleted. A reduced frequency and amplitude was also encountered when Langdendorff isolated cat hearts were perfused with 1 ml of 0.1 molar (13 mg) sodium malate (304). Some clarification of these findings exists in the determination of malic acid as one of the breakdown products of both pyruvate-^{14}C and α-ketoglutaric acid (243). However, these hearts especially when fatigued developed arrhythmic systoles. Sodium malate not only did not correct electrically induced systoles but it had an inhibitory effect on the ability of the heart to contract in all cases (304). Malate in a 5 millimolar glucose perfusion medium did restore anaerobic beating to anoxic hearts to a greater extent than did the control glucose medium (71).

Significant local vasodilation observed in 32 dogs when kidneys and forelimbs were infused at a sub-maximal rate of 2.47 micromoles per minute with malic acid led to the prediction of malic acid playing a potentially important role in the local regulation of blood flow. With the maximum infusion rate, a 20% decrease in renal resistance was experienced (148).

In vitro clotting time of normal human whole blood was not increased by malic acid (164).

In vivo studies showed liver function of rabbits to be only slightly inhibited by the intravenous injection of 0.5 ml of 1 molar malic acid per kg (0.067 mg/kg) (478). The production of malate from propionate in liver slices from normal rats and cows, and ketotic cows has been observed. In the ketotic cows, the ratio of malic acid and the other oxidative metabolic components varied from that of the normal rats and cows which were essentially the same (79). Suggestion that the liver is the site of immediate affect of adrenal cortical hormones on malate stems from comparing (a) fasting adrenalectomized rats, (b) the intact animals and (c) adrenalectomized animals treated with hydrocortisone, prior to receiving malic acid by infusion. The blood levels of glucose were unaffected in groups (a) and (b) but the group (a) animals had a lower glycogen deposition in the liver than did the group (b) animals. This was returned to normal in the group (c) rats as shown in Table 5, page 23 (512).

In contrast, malate seemed to cause fatty infiltration when a 38% hydrogenated oil diet was fed to growing rats. This was accompanied by a lack of protection against cell necrosis and eventual cirrhosis of the liver (166).

In bone, malate has been found in both the active and inactive forms co-precipitated with calcium phosphate. The resultant concentration of 5.5 mg% is 3.5 times the liver malate concentration (254). The incorporation of malate as a total incorporation and bone mineral incorporation

was evidenced in parathyroid treated young growing rats when calvaria, and the metaphyseal and epiphyseal sections of marrow free tibia and fibia were incubated in vitro in Krebs-Ringer bicarbonate buffer containing 2 millimolar glucose and malate (77).

Although the 2 cell mouse embryo showed no ^{14}C uptake from fully carbon labeled, L-malate-U-^{14}C, the 8 cell embryo produced ^{14}C labeled CO_2 and accumulated some substrate ^{14}C. The uptake of the 8 cell embryo was only partially dependent upon the malate concentration but was dependent on temperature as the ^{14}C uptake dropped off sharply when incubation was carried out at 5° C (497).

Reproduction indices of the Albino rats used as test subjects for 1, 000 and 10, 000 ppm dietary studies of malic acid "were similar to those of the controls!' At the diet level of 10, 000 ppm, during the lactation period, the number of first filial generation first litter pups that were weak or showed labored respiration was increased. Caesarean section delivered second filial generation second litter fetuses" showed no meaningful differences" of reproductive parameters from those shown by the control rats. No dead fetuses were encountered.*

White Leghorn chick embryos that survived 17 days of incubation after the L form of malic was injected into the eggs had a significant increase in the percentage of rumplessness when compared to the controls. D-malate under these conditions caused no effect and no other abnormalities were found for either isomer (250). Malic acid has also been identified in the shells of eggs (254).

*Private communication from Allied Chemical Corporation

Injection of malic acid into the nucleus caudatus caused the same type of convulsions as did decamethasone. However, when the injection site was the motor area of the cerebral cortex no spasms were elicited (305). Electrical responses were restored to some degree by malic acid in the presence of glucose to cerebral cortex slices previously rendered defective to respiration in the presence of glucose (299).

Threshold potentials were decreased in both a single toad motor neuron exposed to 0.02 molar malate and its adjacent control incubated in Ringer's solution but the resting potential was only decreased in the malate immersed node (344).

Contrary to other published results, malic acid caused an increased glucuronic acid excretion in the urine (288). Also increased was the respiration of rabbit kidney cortex as measured by oxygen uptake when malic acid was added to modified Ringer's solution. The increases in QO_2 of 1.80 and 3.37 were relatively consistent with the increase of malic acid from 5 mg% to 10 mg% malic acid (402).

When used in conjunction with insulin, malic acid both enhances the effect of exogenous insulin (54) and decreases ketosis to a greater extent (34) than when insulin was administered alone. The ketotic decrease took place in normal and alloxan diabetic female Sprague-Dawley rats fed 4-6 ml of Wesson oil by stomach tube twice daily. This anti-ketotic action of malic acid in diabetic rats takes place only in the presence of insulin. However, in non-diabetic rats, it does reduce ketonuria at dosages sufficient to cause glucosuria, 2 ml/100 g/day of a 13.5% or a 20% glucose solution (34).

The only cancer related study reported was on the inhibitory effect elucidated by manganese malate on transplanted Ehrlich's mouse tumors. Though the anti-tumor activity of cadmium ascorbate was greater than that of manganese malates, the malate toxicity was sufficiently low for therapeutic testing while the reverse was true for cadmium ascorbate. Comparative data are given in Tables 2, 3, 4, page 18(28).

Malic acid was shown to be one of the two most irritating test compounds when placed as solutions of varying concentrations into eye lid slits of rabbits. It was more irritating than phosphoric acid and much more irritating than hydrochloric acid based on the volume of edema produced in the upper palpebral conjunctiva (251a).

The significance of malic acid as a biological agent is many fold. One aspect is the enhancement of gluconeogenic action of L-lactate in rat kidney cortex slices by D-malate whereas D-malate alone produces very little glucose. D-malate also inhibits the gluconeogenesis of L-malate and pyruvate but has little effect on the rate of the tricarboxylic cycle. There is only a slight reduction of glucose formation from malate when 0.1 millimolar aminooxyacetate is added to the incubation medium (402).

Radioactive evidence which indicates that when L-and D-malate are administered to rats by mouth or intraperitoneally the metabolic products are both excreted at the 90-95 % level with 83-92 % of the ^{14}C in the form of carbon dioxide has led to the conclusion that there is no reason to discriminate against D-malate as a food additive (96). This reasoning is questioned when other biological parameters that do not confirm an identity of action for L-and D-malate are evaluated (279, 250, 402).

Consideration of malic acid as an active intermediate in animal metabolism is based in part on the levels of α-ketoglutaric, pyruvic, citric and oxalacetic acids in the blood and urine of animals. A-ketoglutaric acid has been found to be markedly elevated in the urine of rats fed malic acid (431) and in the blood of fasting pregnant ewes after its intravenous injection (387). In both cases, the pyruvic acid was only slightly increased (387, 431). Ewe blood citric acid was also markedly increased while oxalacetic acid showed no consistent trend (387). A change in the shape of the pyruvic saturation curve from sigmoid to hyperbolic was noted in rabbit skeletal muscle when under the influence of malate (147).

Another confirmation of the role of malic acid as a biologically significant compound has been confirmed by its exchange between the mitochondria and cytosol together with reversible malate dehydrogenase activity. This activity tends to equilibrate isotopically in these compartments with the pool of nicotinamide adenine dinucleotide, reduced (NADH) (403). L-malate dehydrogenase inhibition of D-malate has been shown in various tissues of rat kidney cortex (402). Further importance of malate is indicated by the rapid exchange of ^{14}C between L-malate and acetate as determined by radioactivity transfer and production of ^{14}C containing glucose (497).

Activation of papain at an intermediate level by malic acid (342) and of partially purified human prostate acid phosphatase at pH 4.6 by D-malate have been demonstrated (11).

Analytically, DL-malate has been used to differentiate between D-amino acid oxidase and D-aspartic acid oxidase. The procedure takes advantage of studies on in vitro hog kidney that show racemic malic acid inhibits oxidation of D-aspartic acid by D-aspartic acid oxidase but does not inhibit a similar action of D-alanine by D-amino acid oxidase (279).

It was further shown that unlike most other compounds tested, free malic acid injected into the blood of rabbits may cause either a decrease or increase in blood pH. This may be due to the influence of the blood constituents on the formation of malate salts and/or the ionization of the two acids radicals (194).

A probable cause of the decrease of metabolic acetylation in the presence of malic acid in vitro may be its inability to act as a hydrogen acceptor (447).

The total United States poundage in 1970 as reported by the NAS/NRC was 4,170,478 pounds (320b).

The level of use of malic acid in foods is up to 4%. It's main use is in sweet snack, confectionary, and bakery products plus in some flavorings (320a).

The highest possible daily intake of malic acid from all sources by the 2-65+ age group is estimated at 1,829.5 mg (320b), Table 6, pages 33-34.

MALIC ACID

Chemical Information

I. Nomenclature

A. Common names (250a)

1. D-malic acid

2. L-malic acid (naturally occurring isomer)

3. D-L-malic acid

4. α-iso-malic acid

B. Chemical names (250a) (233a)

1., 2., 3. Hydroxysuccinic acid

Hydroxybutanedioic acid

1-Hydroxy-1, 2-ethanedicarboxylic acid

4. Methyl tartronic acid

C. Trade names (300a)

2. Apple acid

1., 3., 4. No trade names encountered in the available literature

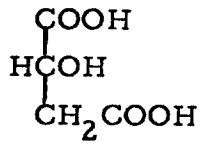
D. Chemical Abstracts Services Unique Registry Number

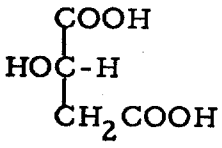
000097-67-6

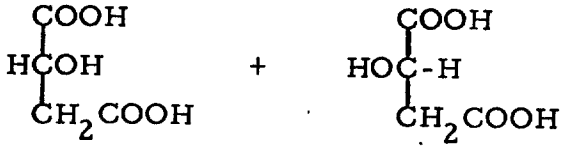
II. Empirical formula (141a)

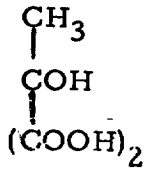
$C_4H_6O_5$

III. Structural formulae (250a) (300a)

1. 

2. 

3. 

4. 

IV. Molecular Weight (141a)

134.09

V. Specifications (300a)

A. Chemical

C	35.83%
H	4.51%
O	59.66%

B. Food Grade (141a)

Assay. Not less than 99.5 percent of $C_4H_6O_5$.

Melting range. Between 130° and 132°.

Limits of Impurities:

- Arsenic (as As). Not more than 3 parts per million (0.0003 percent).
- Fumaric acid. Not more than 0.5 percent.
- Heavy metals (as Pb). Not more than 20 parts per million (0.002 percent).
- Lead. Not more than 10 parts per million (0.001 percent).
- Maleic acid. Not more than 0.05 percent.
- Residue on ignition. Not more than 0.1 percent.
- Water-insoluble matter. Not more than 0.1 percent.

C. Official Compendia

Food Chemical Codex (141a)

VI. Description (141a)

A. General Characteristics

White or nearly white, crystalline powder or granules having a strongly acid taste. One gram dissolves in 0.8 ml. of water and in 1.4 ml. of alcohol. Its solutions are optically inactive.

B. Physical Properties (300a)

• DL-Form: Crystals,	mp 131-132°
• D(+). Form: Crystals,	mp 101°
• L(-). Form: Apple acid, Crystals from acetone or acetone + chloroform	mp 100° decomposes about 140°
• Optical Rotation, $[\alpha]_D$ at a concentration of 8.5 g/100 ml H_2O	-2.3°

Solubility (141a)

Water	freely soluble
Ethanol	71.4%
Propyl alcohol	43.5%
Methanol	133.3%
Ether	58.8%

C. Stability in Containers (141a)

Store in well-closed containers.

VII. Analytical Methods

A. Detection and Quantitation in Foods

1. General

- Fluorometric (32)
- Gas Chromatography (191)

2. Fruits and Fruit Derivatives

- Thin Layer Chromatography (76)
- Polarimetry (131)
- Manometric (240)
- Ion Exchange plus Ultra Violet (165)
- Paper Chromatography (220)
- Gas-Liquid Chromatography (287)

3. Biological Fluids

- Gas Chromatography (526)
- Enzymatic (339)
- Fluorometric (204)

4. Synthetic Mixtures of Food Acids

- Fluorometric (32)
- Thin Layer Chromatography (46)
- Thin Layer Electrophoresis plus Chromatography (341)

B. Procedural Studies

- Paper Electrophoresis-High Voltage (172)
- Gas Chromatography (190)
- Fluorometric (444)

VIII. Occurrence and Levels Found in (233a)

A. Plants

Malic acid has been found in cultures of a variety of microorganisms including Aspergilli, yeast, Sclerotinias, and Penicillium brevi-compactum. Among the Rhizopi, it occurs together with L(+)-lactic acid and fumaric acid. Fruit sources of malic acid as the percent of total acid content are given in Table 1.

Table 1. Malic Acid in Fruits

Fruit	% of total acid	Fruit	% of total acid
apple	97.2	orange pulp	trace
apricot	23.7-69.8	peach	50.0-96.2
banana	53.7-92.3	pear	33.0-86.6
blueberry	6.0	persimmon	100.0
cherry	94.2	pineapple	12.5
cranberry	19.1-23.5	plum	98.5
gooseberry	46.2	quince	100.0
grape (Concord)	60.0	rhubarb	77.0
grapefruit	5.6	strawberry	9.9-11.0
lemon	4.5	watermelon	100.0
orange peel	59.6-80.0		

B. Animals

No information was encountered in the available literature.

C. Synthetics

No information was encountered in the available literature.

D. Natural inorganic sources

No information was encountered in the available literature.

Biological Aspects

I. Acute Toxicity

The acute toxicity of malic acid was found to be 2,400 mg/kg for rabbits of 2 kg weight when a 106 ml of a 0.25N solution was injected into the Vena jugularis dextra. This was not stated to be an LD_{50} and was the result for approximately 4 rabbits (194).

II. Short Term Studies

Perhaps because malic acid is a common food acid, the number of controlled studies on the toxicity of malic acid encountered in the available literature was limited.

The effect of carbohydrate metabolism disruption on the aorta wall and the development of alimentary fat accumulation was studied by administering 70 mg/kg of cholesterol daily and 300 mg of malic acid intraperitoneally twice a week for 5 months to rabbits. These 2.7 - 3.0 kg animals showed a doubling of the cholesterol level due to the injection of malic acid over the value of 371 mg% found for comparative rabbits receiving only 70 mg/kg/day of cholesterol. Malic acid without the added cholesterol did not increase the normal blood cholesterol level of 70 mg% but revealed the initial stages of elastic fiber degeneration and an accumulation of acid mucopolysaccharides in aortic sections. This was followed by atherosclerotic changes in the vessel walls due to an aggregation of decomposition products and an accumulation of collagen. A more severe degeneration of the intima and medial of the aorta as well as a general lipogenesis with marked atheromatous foci was observed when the rabbits

were simultaneously fed cholesterol and malic acid than when cholesterol was fed alone. These deleterious changes in the aorta wall may have been due to an interference by malic acid with the normal oxidative processes of the Krebs cycle as seen in similar studies when citric and fumaric acids were tested (33).

Where rabbits were fed cholesterol prior to being fed malic acid, the blood plasma cholesterol returned to normal within 30-50 days. This drop in the cholesterol level was accompanied by a reduction of total cholesterol and total lipid content in the organs of the rabbits (225).

A decrease in ketosis was greater using insulin plus malic acid than when insulin was used alone in alloxan-diabetes of 4 weeks duration on 200-220 g female Sprague-Dawley rats. They had been fed 4-6 ml of Wesson oil by stomach tube twice daily for one week on alternating weeks. Amphogel and tincture of opium were also administered to prevent diarrhea. Malic acid by itself did not reduce ketonuria in the diabetic rats as it does in non-diabetic rats. The dosage of malic acid adjusted to pH 4.5 was sufficient to cause glucosuria. Based on possible oxalacetate production the amount administered was equivalent to 2 ml/100 g/day of a 13.5% or a 20% glucose solution. No mention of any co-effect on the mice due to the toluene under which the urine was collected was considered (34).

Manganese malate, one of the tumor inhibiting manganese complexes which along with other substances influencing oxidation and reduction that were tested for anti-tumor activity on transplated Ehrlich's mouse tumors, was found to be more tumor inhibiting than all of the other salts tested except cadmium ascorbate. Nine series of 5 to 10, 10 g male and female white mice that received the tumor cells were dosed intraperitoneally with 10 mg/kg/day of manganese malate for 13 or 10 days. Only significant results were reported. Comparative data on two series of tests and on significant differences of tumor inhibition are given in Tables 2, 3, & 4. Manganese malate and citrate had the advantage over cadmium ascorbate of lower toxicity as tumor inhibitors. In fact, the toxicity of manganese malate is sufficiently low to permit therapeutic testing (28).

Table 2

Effect of manganese-malate and manganese-citrate complexes on the growth of mouse cancer.
The mice were treated for 13 days by intraperitoneal injections

Compound	Mn-malate complex	Mn-citrate complex	Control
Daily dose	200 µg	200 µg	
Weight of the single tumours	0,81	1,18	3,20
	0,80	1,13	2,92
	0,76	0,96	2,52
	0,75	0,84	2,36
	0,73	0,74	1,98
	0,70	0,73	1,63
	0,65	0,66	1,53
	0,50	—	1,43
	0,50	—	1,23
	—	—	1,20
Mean	0,68	0,89	2,00
Standard deviation	0,11	0,18	0,67
Student's variable	6,11	2,96	—
Significant diff.	6,13	5,01	—

Table 3

Effect of manganese-malate complex on the growth of mouse cancer.
The animals received 10 intraperitoneal injections

Daily dose	200 µg	Control
Weight of the single tumours	1,58	3,45
	0,77	2,80
	0,50	2,47
	0,49	2,20
	0,47	1,57
	0,46	1,45
	0,46	1,17
	0,40	1,00
	0,39	1,00
	—	1,00
Mean	0,61	1,83
Standard deviation ..	0,35	0,83
Student's variable	3,86	
Significant difference .	4,25	

Table 4

Comparison of tumour inhibitors on basis of the significant differences

Cd-ascorb. compl.	Mn-malate compl.	Mn-citrate compl.	Mn-ascorbic acid compl.
8,33	6,13	5,01	3,61

Reference*

Method:

Species: Dog

Strain: Young adult purebred beagles

Sex: Male and Female

Number of Animals: 8 groups of 4

Body Weight: 6.9 to 14.5 kg

Duration of Study: 104 weeks

Vehicle, solvent or carrier: Ground Wayne Dog Meal

Dose Schedule: 0; 500; 5,000; 50,000 ppm in diet

Route of Administration: Oral

Observations:

Body weight changes showed no dose-related pattern and the dogs appeared, ate, behaved, and eliminated normally throughout the 104 weeks.

Clinical laboratory studies of the blood and urine "failed to reveal compound-related alterations or trends at any dosage level". An elevation of urine bilirubin was found consistently for all male groups at the higher dosage level, the rise was less marked.

Gross and histological pathology showed only incidental tissue alterations which were considered not to be attributable to the malic acid.

*Private communication from Allied Chemical Corporation

III. Long Term Studies

Reference*

Method:

Species: Rats

Strain: Albino-Charles River

Sex: Male and Female

Number of Animals: 2 groups of 60, 6 groups of 30

Body Weight: Males- 0.125 - 0.177 kg,
Females- 0.107 - 0.149 kg

Duration: 104 weeks

Vehicle, solvent or carrier: Purina Laboratory Chow

Dose Schedule: 0; 500; 5,000; 50,000 ppm

Route of Administration: Oral

Observations:

During the first year, the appearance and behavior of the test rats was similar to the control rats. The respiratory involvement was lowest for the 50,000 ppm test males and highest for the male controls. In the first year, the high dosage males and females showed a predominance of the hunched appearance and/or alopecia other than that observed in all groups. This leveled off through the groups in the second year. Six high level dosage male rats developed protruding eyes during the second year of the study. This observation was also made in a few females from each group. Urine stains were less frequent in the test groups. The following number of externally palpable nodules or tissue masses were exhibited:

*Private communication from Allied Chemical Corporation

Group No.	No. of Animals			
	First Year		Second Year	
	male	female	male	female
1	2	5	6	23
2	2	2	4	10
3	0	4	2	12
4	1	0	7	5

Growth was significantly depressed in all test animals for the first year but it was similar to the test group thereafter. Food intake in the high level dosage males was significantly reduced during the first year. Though reduced in the paralledl group of females, the decreased food intake was not considered significant for the entire first year but was significant during the first 26 weeks. Some increase in food consumption took place during the second year. Better performance for the high level dosage males than their control counterparts is seen in the following survival data:

Group No.	Mean Survival Time - Days		Percent Survival at 104 Weeks	
	male	female	male	female
1 (Control)	620.4	667.4	38.3	55.0
2	561.5	672.7	30.7	50.0
3	672.5	668.0	30.0	55.6
4	704.6	704.7	80.9	75.0

Clinical laboratory studies on the blood and urine revealed no alterations that could be attributed to malic acid.

Gross pathology showed no organ changes at death, interval necropsy, or terminal sacrifice related to the experimental substance. The findings in the test animals were in general similar to those observed in the control animals.

The organ weight variations were considered to be incidental because of a lack of malic acid related histopathology of the rat tissues. However, those weights showing significant differences from the controls were for rats on the 50, 000 ppm diet: at 26 weeks lower male thyroids, and lower heart and body weight for the females; at 52 weeks higher testes and lower liver weights for the males and lower body weights for the females; at the termination of the experiment, 104 weeks, higher spleen and lower kidney weights for the males and lower thyroid weights for the females.

Microscopic pathology did not reveal any malic acid "related changes in the tissues examined." Spontaneous aging changes were noted in both the test and control rats at a comparable incidence and severity as was the incidence and histologic of neoplasms observed. The following items are noted: two high level dosage males had testicular atrophy with reduction in spermatogenic activity; 3 of 5 of the 500 ppm, 2 of 5 of the 5, 000 ppm and 3 of 10 of the 50, 000 ppm malic acid test females experienced mammary gland fibroadenomas but 9 of 10 female controls exhibited similar fibroadenomas.

IV. Special Studies

The effect of malic acid, a Krebs cycle metabolite (71), on the function of the heart, aorta, and other blood vessels, and in relation to cholesterol and atheromatosis has received the major attention in the malic acid studies.

In spite of an atherogenic diet of 200 mg/kg of cholesterol fed to rabbits, a 1,000 mg/kg dose of malic acid decreased the cholesterol and total lipid content in the liver, adrenals, and aorta (224). These results are in contrast to those obtained at the 70 mg/kg/day dosage level of cholesterol that showed a two-fold increase of cholesterol when 300 mg/kg malic acid was injected intraperitoneally (33).

Myocardial insufficiency associated with extremely low creatine phosphate was demonstrated after 58 minutes when an artificial blood containing 1.0 millimolar malate as a substrate was perfused through the hearts of 2.2 - 3.0 kg rabbits in situ. Pronounced decreases also occurred in ATP and glycogen in the ventricular muscle. The infusion time for the substrate free controls was 30-35 minutes (470).

Isolated rabbit auricles showed a depressed rate and amplitude of contraction due to malate. As the concentration of this substrate was depleted, the amplitude of the auricular beat continued to decrease but the rate

remained stable. The action of malate and other substrates tested led to the conclusion that unknown metabolic pathways exist in cardiac muscle (501). Some clarification of this complex problem has resulted from studying the breakdown products of pyruvate -^{14}C and α-ketoglutarate. In both of these biochemical systems, malate was determined to be one of the metabolic products found in the mitochondria of homogenized hearts from 1 to 1 1/2 kg rabbits (243).

A potentially important role as a vasodilating metabolite in the local regulation of blood flow has been predicted for malate and other Krebs cycle intermediates. This conclusion has been drawn from the significant vasodilation observed in 32 dog kidneys or forelimbs which were infused with these compounds by the submaximal dosages of 2.47 micromoles per minute without changing the systemic pressure. Added validity of this role for malate and the other intermediates is the demonstration of a 20% decrease in renal resistance at the maximum infusion rates in comparison to no vascular effect when saline was similarly administered (148).

It is reported that a perfusion of 1 ml of 0.1 M (13 mg) sodium malate induced arrhythmic systoles in the fatigued Langdendorff isolated cat heart. There generally was a decreased frequency and amplitude when the heart movement was steady and strong. Electrically induced arrhythmias did not improve with the malate perfusion. It had an inhibitory and injurious effect on the contractility of the heart in all cases (304).

20

Beating of the anoxic hearts of 300-350 g Sprague-Dawley male rat was restored to a greater extent by malic acid than was promoted by the use of glucose alone. The malate effect was additive with that of fumarate and glutamate when these substrates were co-tested. The Krebs-Ringer bicarbonate at pH 7.4 perfusion medium contained 10 mM malic acid and 5mM glucose. A 21-minute oxygen saturation preceded the 75-minute infusion at a rate of 7 ml/minute (71).

When compared to tricarboxylic acids, malic acid and other dicarboxylic acids were relatively ineffective in increasing the in vitro clotting time of normal human whole blood. However, the average of seven, 2 ml samples when mixed with 0.5 ml of 0.23 molar malic acid neutralized to pH 7 showed a four-fold increase of the clotting time (164).

A slight inhibitory effect on liver function of rabbits was noted after intravenous injection of 0.5 ml of a 1 M solution of malic acid per kilogram of body weight (478).

Growing rats fed a diet containing 8% casein; 38% Crisco, a hydrogenated vegetable oil; and 48% glucose, salts and vitamins were afforded no protection by malate against the resulting fatty infiltration cell necrosis, and eventual cirrhosis of the liver. To the contrary, malate seemed to promote fatty infiltration (166).

Fasted adrenalized male Wistar rats weighing 180-220 g infused for 90 minutes with 3.34 meq of malate at pH 4 in 3 ml of water resulted in less glycogen deposition in the liver than in 5 or 6 intact animals yet the blood glucose levels were not affected by adrenalectomy. When prior treatment with hydrocortisone was carried out, the liver

glycogen was returned to the control levels. Table 5 enumerates the data for parameters studied. These values and concurrent results suggest that the liver is the site of the immediate effect of adrenal cortical hormones on malate and other carbohydrates (512).

Using 1 ^{14}C labeled aliphatic acids, the oxidative metabolic patterns in normal and ketotic cow liver slices were delineated. Malate was one of the non-volatile products identified when the incubation bath contained propionate. Only an altered distribution of intermediates was found in the ketotic cow liver slices. Rat liver slices under the same conditions showed no marked variations from the results encountered with normal cows (79).

Malate presence in compact bone has been confirmed to the extent of 5.5 mg% which is 3.5 times its liver concentration. It appears to be co-precipitated with calcium phosphate both in the metabolically inactive and active forms. The metabolic interaction was traced by the uptake of radioactivity by malate to intermediate levels when the bone was incubated with labeled acetate. Malic acid was also identified in varying quantities in egg shells (254).

Incorporation of labeled malate and citrate in bone was enhanced in young growing parathyroidectomized male Sprague-Dawley rats weighing 120-150 g treated with 500 units of parathyroid extract over a period of 3 days compared to the controls that received 0.85% sodium chloride. These results were obtained by incubating the calvaria, and the metaphyseal and epiphyseal sections of marrow free tibia and femora in vitro for

TABLE 5. EFFECT OF THE INFUSION OF VARIOUS SUBSTANCES ON CARBOHYDRATE METABOLISM OF INTACT, ADRENALECTOMIZED, AND ADRENALECTOMIZED RATS TREATED WITH HYDROCORTISONE

Substance infused	Amount Mg./100 g.m./B.W.	No.	Liver glycogen		Muscle glycogen, Mg.%	Blood sugar, mg.%		Urinary excretion, mg./100 gm./B.W.
			Mg.%	Mg./100 g.m./B.W.		Initial	Final	
Normal								
None	—	4	117	4	478 ± 43	—	—	—
Glucose	122	6	1130	38	502 ± 11	73 ± 4	137 ± 7	0
Fructose	155	7	1900	71	530 ± 17	80 ± 6	153 ± 11	10 ± 3
Glycerol	119	6	1180	40	471 ± 14	69 ± 4	95 ± 4	—
Lactate	136	5	1420	44	528 ± 25	70 ± 2	87 ± 1	5 ± 2
Malate	142	5	570	18	479 ± 33	78 ± 3	98 ± 2	—
Adrex.								
None	—	11	27	1	457 ± 8	—	—	—
Glucose	130	6	500	16	489 ± 9	68 ± 6	198 ± 14	Trace
Fructose	124	6	810	25	477 ± 7	63 ± 4	151 ± 18	4 ± 0.8
Glycerol	130	7	280	9	406 ± 8	55 ± 3	85 ± 5	—
Lactate	119	8	128	3	444 ± 12	57 ± 3	84 ± 5	2 ± 0.5
Malate	149	6	31	1	539 ± 15	61 ± 3	101 ± 10	—
Adrex.+hydrocortisone								
None	—	4	1000	31	451 ± 10	—	—	—
Glucose	146	6	1980	66	454 ± 8	94 ± 5	259 ± 24	4 ± 4
Fructose	148	6	2970	108	467 ± 15	93 ± 2	179 ± 20	13 ± 1
Glycerol	145	5	1800	60	436 ± 18	85 ± 5	116 ± 8	—
Lactate	129	6	1730	54	484 ± 11	83 ± 1	114 ± 7	6 ± 2
Malate	151	6	1450	46	490 ± 19	96 ± 2	109 ± 12	—

2 hours at 37° in Krebs-Ringer bicarbonate buffer containing 2 millimolar ^{14}C labeled glucose and of the unlabeled test material. Increase of labeled malate as well as the citrate was both as a total accumulation and a bone mineral incorporation. The control bone sections showed malic acid to be incorporated in the bone mineral to a higher degree than were the other test tricarboxylic cycle intermediates. In the treated animals, the greatest total uptake and bone accumulation was that of malic acid (77).

When incubated for 30 minutes with L-malate-U-^{14}C, two cell mouse embryos did not absorb or utilize the labeled malate as no detectable ^{14}C was produced in these cells. However, by the 8 cell stage, substrate carbon was accumulated and some L-malate-U-^{14}C was oxidized to $^{14}CO_2$. A partial lack of dependence on the concentration of malate was shown by a reduction in the uptake of substrate carbon by the 8 cell embryo of only 25% when the malate concentration in the medium was reduced by a factor of 10 to 1.17×10^{-4} molar, while the glycoside ouabain at 10^{-7} - 10^{-5} molarity had no effect on the substrate carbon accumulation. A temperature dependence was encountered when a sharp reduction of uptake occurred during an 8 cell embryo incubation at 5°C (497).

Teratogenicity in the form of a rumplessness induced by the injection of L and D forms of malic into White Leghorn egg yolks before incubation showed opposite results. The L-malic acid caused significant increases over the control in the frequency of rumplessness in those embryos surviving the 17th day while D-malic acid had no effect under

the same conditions. No significant increase in abnormalities due to testing procedures using the malates and other compounds was noted in the embryos surviving the 17th day (250).

It has been found that malic acid acted in a manner essentially similar to that of the drug Decadron®, decamethasone. Convulsions were encountered when both materials were injected into the nucleus caudatus but not when injected into the motor area of the cerebral cortex (305). Isolated mammalian cerebral cortex slices maintained at 37° under appropriate metabolic conditions but lacking glucose and inactivated to glucose by electrical pulses responded metabolically to some degree when malic acid was added along with glucose. Malic acid was metabolically more responsive under these conditions than most of the substrates studied (299).

Both the threshold and resting potential of a single toad motor neuron exposed to 0.02 M malate were decreased when compared to an adjacent control node immersed in Ringer's solution. This node also experienced a decrease in its threshold value but no effect on the resting potential was recorded (344).

When 4,000 mg/kg/day of malic acid was orally administered to 40 rats, an increased glucuronic excretion was detected in the urine. Similar results were experienced for some and the opposite for the remainder of the other test chemicals (288).

Measurements of the tissue respiration of rabbit kidney cortex as determined by the oxygen uptake increased when malic acid was added to modified Ringer's solution. Warburg method measurements

showed an increase from Q_{O_2} 26. 38 for the control to 28. 18 and 29. 75 for 5 mg% and 10 mg%, respectively, of malic acid in the tissue bath (290).

It was found that malate and a few other intermediary metabolites enhanced the effect of exogenous insulin when these materials were injected simultaneously (54).

The edema producing potency of malic and other organic acids was measured in morphinized male 2 kg Albino rats by placing the irritating solution of one of the 6 molarities tested in a pocket made in the eyelid of 5 rats. After 3 minutes of holding the solution in place followed by a one-hour waiting period, the rats were sacrificed and the increase in moisture in the upper palpebral conjunctiva was determined. This value plus the log of the molar concentration was considered the edema producing potency of the acids tested. Comparing the level of 2. 5 of these units, approximately 50% moisture gain, malic acid was found to be more irritating than phosphoric acid and 4 times as irritating as hydrochloric acid. Along with succinic acid, another dibasic saturated acid, it was the greatest edema producer (251a).

Reference*

Method:

Species: Rats

Strain: Albino weanling rats-Charles River-derived

Sex: Male and Female

Number of Animals: 3 groups of 10 males, 3 groups of 20 females

Body Weight: Males- 0.132 - 0.168 kg
Females- 0.114 - 0.141 kg

Vehicle, solvent or carrier: Purina Laboratory Chow

Dose Schedule: Weaning of second filial generation
0; 1,000; 10,000 ppm

Route of Administration: Oral

Observations:

In the reproduction phases, the rats were generally normal in appearance except for incidental laboratory diseases. Litter sizes and pup body weights were comparable in all of the control and test groups. All of the necropsied 1st litter pups on 1,000 ppm malic acid showed rough surfaces on the spleen. The number of pups that evidenced weak or labored respiration during lactation was higher at the 10,000 ppm dosage level.

During the second reproduction stage one female was found dead with adverse necropsy the day after weaning. Two males died after breeding. The one necropsied had diseased lungs.

*Private communication from Allied Chemical Corporation

In the second fileal generation adverse necropsy was found in the kidneys and spleen. One 10, 000 ppm pup had cecum involvement.

Upon Caesarean section of the 2nd fileal generation, there were meaningful variations in the test parameters of the parents. No dead fetuses were found.

At the 10, 000 ppm dosage in two fetuses, an extra ossification center between the interparietal and occipital bones and an interparietal bone splits were present. A single 14th rib was found in a fetus on the high level diet. Skeletal development was felt to be within the normal variation.

Biochemical Aspects

I. Breakdown

None noted in available literature.

II. Absorption - Distribution

None noted in available literature.

III. Metabolism

Embryonic studies previously discussed showed the production of $^{14}CO_2$ and uptake of C from L-malate-U-^{14}C (497). In the more complex tissue of starved rat kidney cortex, glucose was detected when slices were incubated in a medium containing L-malate-U-^{14}C plus unlabeled acetate or acetate -1-^{14}C plus unlabeled malate. Upon isolating and determining the glucose levels by chromatographic and radioactive technics, the activity of the ^{14}C labeled glucose agrees with the predicted value in both approaches if rapid malate exchange between the cytosol and mitochondria is assumed. This was established and found to be at least several times the rate of glucose formation. Added biological significance to malate is its exchange between compartments together with reversible malate dehydrogenase activity in the mitochondria and cytosol tending to equilibrate isotopically with the nicotinamide-adenine dinucleotide, reduced;NADH; pool in these compartments (403).

Other gluconeogenesis experiments on rat kidney cortex slices show that incubation in D-malate alone formed very little glucose but did augment gluconeogenesis when D-malate was added to an L-lactate incubation medium. In contrast, under similar conditions, D-malate inhibited gluconeogenesis from pyruvate and L-malate. Little effect was noted on the rate of the tricarboxylic acid cycle with or without other substrates. The activity of L-malate dehydrogenase was inhibited by D-malate in a high-speed supernatant fraction from the kidney cortex. The role of malate as the carrier for carbon and reducing equivalents in gluconeogenesis is supported by the findings that D-malate inhibits either the operation of cytoplasmic L-malate dehydrogenase or malate outflow from the mitochondria in the intact kidney cortex cell. The formation of glucose from malate in the kidney cortex slices was only slightly reduced by a low, 0.1 millimolar, concentration of aminooxyacetate added to the medium. Only L-lactate gluconeogenesis was strongly inhibited by aminooxyacetate (402).

Radiocarbon tracing of the conversion of L and DL malic acids given orally and intraperitoneally to rats detected that 90 - 5% of the radioactivity was excreted within 24 hours. The expired air contained 83-92% of the ^{14}C from both the radioactive malic acid preparations as carbon dioxide. As there was no difference in the excreted metabolites of these acids regardless of the route of administration, the scientists who reported these results felt that there appeared to be no

justification for discriminating against the use of the D-malic acid as a food additive (96). Some of the other studies cited show biological and metabolic differences between D and L malic acids when different parameters are measured (279, 250, 402).

The urine of rats orally dosed with malic acid yielded large amounts of α-keto-glutaric acid and slight increased in the amount of pyruvic acid found. Thus, malic acid as well as some other plant acids are considered to be active intermediates in animal metabolism (431).

The similarity of sheep and human values for the blood of pyruvic, citric and α-keto-glutaric acids governed the decision to use sheep as the test animal for the influence of malate on carbohydrate metabolism. It was intravenously injected into fasting pregnant ewes. The resulting small increase in blood glucose may have been responsible for the lowered blood ketones. Note must be taken in evaluating the blood glucose levels that the experimental animals were insufficiently trained for experimental purposes. Blood pyruvic acid was also slightly increased but no consistent in crease in blood oxalacetic acid occurred following the above injection of malate. However, the blood citric and α-keto-glutaric acids were markedly increased under the same conditions (387).

IV. Effects on Enzymes and Other Biochemical Parameters

A support of the role of malate as carrier for carbon and reducing equivalents in gluconeogenesis (244a, 251) has been demonstrated in rat kidney cortex by the D-malate inhibition of either the operation of the cytoplasmic L-malate dehydrogenase or malate outflow from the mitochondria in the intact cells. D-malate also inhibited L-malate dehydrogenase activity in high speed supernatant fractions in the kidney cortex (402). Another study on rat kidney cortex indicates that in the mitochondria and cytosol, malate exchange between compartments together with reversible malate dehydrogenase activity tends to equilibrate isotopically with the nicotinamide-adenine dinucleotide, reduced; NADH; pool (403).

Malate and some other related acid radicals which activate lactic dehydrogenase isozyme 5 in rabbit skeletal muscle change the shape of the pyruvate saturation curve from sigmoid to hyperbolic. Lactic dehydrogenase was not so effected (147). Other enzyme studies show that with malic acid there is activation of papain at a level between that of fumaric and dihydroxyfumaric acids (342) and activation of partially purified human prostate acid phosphatase takes place at pH 4.6 with D-malic and other α-substituted acids (11).

An invitro study on hog kidney of the degree of competitive action of DL-malic acid (a) on the oxidation of D-alanine by D-amino acid oxidase and (b) of D-aspartic acid by D-aspartic acid oxidase was used to further differentiate between the two enzymes. No inhibition was seen due to malic acid in reaction (a) but there was competitive inhibition in reaction (b). These and related results on L-tartaric acid may aid in clarifying the stereospecificity of D-aspartic acid oxidase (279).

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After the injection of free malic acid into the circulating blood of 2 kg rabbits, the pH of the blood was variable and ambivalent, it was both increased and decreased (194).

In vitro experiments in conjunction with in vivo rabbits studies on metabolic acetylation showed that malic acid, a precursor of the tricarboxylic acid cycle, decreases acetylation. This may be related to malate not a hydrogen acceptor (447).

V. Drug Interaction

A decrease in ketosis was greater using insulin plus malic acid than when insulin was used alone in alloxan-diabetes of 4 weeks duration on 200-220 g female Sprague-Dawley rats. They had been fed 4-6 ml of Wesson oil by stomach tube twice daily for one week on alternating weeks (34).

VI. Consumer Information

The level of use in frozen foods, beverages, bakery, and similar products, and confectionaries is up to 4%.

Fruit butter, jellies, jams, and preserves both naturally and artificially sweetened may contain sufficient malic acid to compensate for a deficiency of fruit acidity. It is also used in citrus, fruit, mint, and vanilla flavoring (320a).

Table 6 gives the probable average, high, and maximum levels expected to be used by humans according to age (320b).

TABLE 6 (con't) -- POSSIBLE DAILY INTAKES OF NAS APPENDIX A SUBSTANCES (GROUPS I & II), PER FOOD CATEGORY AND TOTAL DIETARY, BASED ON FOOD CONSUMPTION BY TOTAL SAMPLE

SUBSTANCE NAME (SURVEY NO.)	FOOD CATEGORY NO. NAME	# OF FIRMS	(AGE)	POSSIBLE DAILY INTAKE, MG. AVERAGE	HIGH A	HIGH B
MALIC ACID NAS 0118	18 JAM JELLY(P)	8	0-5 MO.	**********	1.126500	**********
			6-11 MO.	25.160510	83.742190	30.737030
			12-23 MO.	11.269000	42.039360	17.702700
			2-65+ YR.	21.405210	66.468810	33.006130
MALIC ACID NAS 0118	20 GELATIN PUD(R)	5	0-5 MO.	.907200	1.332720	2.107600
			6-11 MO.	6.318080	19.151690	19.888640
			12-23 MO.	6.811680	16.584900	21.442440
			2-65+ YR.	10.069440	25.914000	31.697520
MALIC ACID NAS 0118	21 SOUPS(R)	*	0-5 MO.	.044790	.335850	.103640
			6-11 MO.	5.216870	18.277520	22.550600
			12-23 MO.	7.791720	21.516790	33.603360
			2-65+ YR.	7.097620	18.910550	30.691940
MALIC ACID NAS 0118	22 SNACK FOODS(R)	*	0-5 MO.	**********	.011900	**********
			6-11 MO.	.047600	.120900	.201320
			12-23 MO.	.130900	.369900	.553630
			2-65+ YR.	.154700	.440300	.654290
MALIC ACID NAS 0118	23 BEV TYPE I(R)	28	0-5 MO.	2.422760	3.633640	5.400240
			6-11 MO.	22.824730	78.460350	51.077270
			12-23 MO.	54.736590	144.109750	121.089420
			2-65+ YR.	105.029000	280.449230	234.010400
MALIC ACID NAS 0118	24 BEV TYPE II(R)	*	0-5 MO.	.000000	.000000	.000000
			6-11 MO.	**********	.161940	**********
			12-23 MO.	**********	.323880	**********
			2-65+ YR.	52.630500	152.871360	62.086750
MALIC ACID NAS 0118	27 GRAVIES(R)	*	0-5 MO.	.075760	.227280	.001110
			6-11 MO.	1.060640	2.994640	1.135540
			12-23 MO.	2.727360	7.727520	2.919960
			2-65+ YR.	6.280080	16.136880	6.732130
MALIC ACID NAS 0118	30 HARD CANDY(R)	4	0-5 MO.	.000000	.000000	.000000
			6-11 MO.	.098060	.290880	.277040
			12-23 MO.	.296880	.800640	.851120
			2-65+ YR.	.593760	1.602320	1.662240
MALIC ACID NAS 0118	31 CHEWING GUM(R)	*	0-5 MO.	**********	**********	**********
			6-11 MO.	.735000	.735000	.735000
			12-23 MO.	.735000	2.205000	.735000
			2-65+ YR.	1.470000	2.940000	1.470000
MALIC ACID NAS 0118	34 INS COF TEA(R)	*	0-5 MO.	.050000	.825000	.600000
			6-11 MO.	1.325000	5.275000	15.000000
			12-23 MO.	1.050000	5.600000	18.600000
			2-65+ YR.	30.275000	64.850000	363.300000
MALIC ACID NAS 0118	ALL CATEGORIES ********** ********** **********	74	0-5 MO.	21.627160	91.075070	41.121290
			6-11 MO.	283.706830	810.901220	515.884660
			12-23 MO.	462.307000	1069.961980	870.[illegible]000
			2-65+ YR.	745.632710	1829.476970	1654.[illegible]950

TABLE 6 -- POSSIBLE DAILY INTAKES OF NAS APPENDIX A SUBSTANCES (GROUPS I & II), PER FOOD CATEGORY AND TOTAL DIETARY, BASED ON FOOD CONSUMPTION BY TOTAL SAMPLE

SUBSTANCE NAME (SURVEY NO.)	FOOD CATEGORY NO. NAME	# OF FIRMS	(AGE)	POSSIBLE DAILY INTAKE, MG. AVERAGE	HIGH A	HIGH B
MALIC ACID NAS 0118	01 BAKED GOODS(R)	7	0-5 MO.	.338980	.448650	.405620
			6-11 MO.	2.532380	5.164460	3.030220
			12-23 MO.	5.483650	10.953060	6.581850
			2-65+ YR.	13.678040	20.318960	16.367960
MALIC ACID NAS 0118	02 BREAK CERLS(R)	4	0-5 MO.	.724920	2.053940	.861300
			6-11 MO.	26.942860	72.250360	32.011650
			12-23 MO.	31.534020	61.497380	37.466550
			2-65+ YR.	24.164000	62.584760	28.710000
MALIC ACID NAS 0118	04 FATS OILS(R)	*	0-5 MO.	.500000	.500000	2.500000
			6-11 MO.	2.800000	7.500000	14.000000
			12-23 MO.	6.300000	12.000000	31.500000
			2-65+ YR.	17.500000	31.600000	87.500000
MALIC ACID NAS 0118	05 MILK PRODS(R)	*	0-5 MO.	.580040	.403600	.580040
			6-11 MO.	6.795360	32.630890	6.795360
			12-23 MO.	5.935050	10.992160	5.935050
			2-65+ YR.	4.301550	13.133840	4.301550
MALIC ACID NAS 0118	07 FRCZN DAIRY(R)	4	0-5 MO.	.117000	.479700	.239000
			6-11 MO.	1.111500	3.088800	2.279050
			12-23 MO.	1.664800	3.954600	3.454560
			2-65+ YR.	2.995200	7.218900	6.141440
MALIC ACID NAS 0118	08 PROCSD FRUT(R)	12	0-5 MO.	20.416140	27.991120	21.812960
			6-11 MO.	114.709160	295.692000	230.766120
			12-23 MO.	222.949720	442.579140	454.644964
			2-65+ YR.	262.176460	555.379720	538.935220
MALIC ACID NAS 0118	10 MEAT PRODS(R)	4	0-5 MO.	.561220	1.479580	.920260
			6-11 MO.	10.561140	20.469160	17.317620
			12-23 MO.	15.406040	26.479380	25.265920
			2-65+ YR.	38.999600	86.277020	65.949440
MALIC ACID NAS 0118	14 PROCSD VEGS(R)	*	0-5 MO.	.000700	.002100	.001020
			6-11 MO.	.012000	.020000	.031200
			12-23 MO.	.010500	.030450	.050700
			2-65+ YR.	.042500	.071600	.110500
MALIC ACID NAS 0118	16 SOFT CANDY(R)	7	0-5 MO.	5.008640	50.086400	5.008760
			6-11 MO.	55.095040	170.293760	55.095060
			12-23 MO.	87.651200	232.901760	87.653300
			2-65+ YR.	145.250550	440.760320	145.254040
MALIC ACID NAS 0118	17 CONF FRCST(R)	*	0-5 MO.	**********	.170000	**********
			6-11 MO.	.170000	.340000	**********
			12-23 MO.	.340000	1.190000	**********
			2-65+ YR.	.510000	1.360000	**********

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